

# बजट परिणाम

## OUTCOME BUDGET

### 2014-2015

भारत सरकार  
अन्तरिक्ष विभाग



**GOVERNMENT OF INDIA**  
**DEPARTMENT OF SPACE**

**OUTCOME BUDGET  
OF THE  
DEPARTMENT OF SPACE  
GOVERNMENT OF INDIA  
2014-2015**

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## EXECUTIVE SUMMARY

1. The primary objective of the Indian Space Programme is to achieve self-reliance in Space Technology and to evolve application programme to meet the developmental needs of the country. Towards meeting this objective, two major operational space systems have been established – the Indian National Satellite (INSAT) for telecommunication, television broadcasting and meteorological service and the Indian Remote Sensing Satellite (IRS) for natural resource monitoring and management. Two operational launch vehicles, Polar Satellite Launch Vehicle (PSLV) and Geosynchronous Satellite Launch Vehicle (GSLV) provide self reliance in launching IRS & INSAT Satellites respectively.
2. The Department of Space (DOS) and the Space Commission was set up in 1972 to formulate and implement Space policies and programmes in the country. The Indian Space Research Organisation (ISRO) is the research and development wing of the Department of Space and is responsible for executing the programmes and schemes of the Department in accordance with the directives and policies laid down by the Space Commission and the DOS. The Space programme is executed through the ISRO Centre/Units and the Grant-in-aid Institutions.
3. The overall thrust of the Space programme envisaged during 12th plan period will be sustained and strengthened in the already established space based services in the areas of Earth Observation, Satellite Communication, Disaster Management Support and Societal applications such as Tele-medicine, Tele-education and Village Resource Centres and to undertake advanced space missions including Aditya-1 and Chandrayaan-2. The details of the programmes envisaged during the 12<sup>th</sup> Plan period are dealt in para 4 of Chapter 1.
4. The Budget proposals for the Department of Space for 2014-2015 have been formulated under the framework of Decade Profile 2010-2020 and the Twelfth Five Year Plan (2012-2017). The BE 2014-2015 for Department of Space stands at ₹ **7238.04 Crores** comprising of ₹ **6000.04 Crores** 'Plan' outlay and ₹ **1238.00 Crores** 'Non-plan' outlay. The outlay has been arrived at taking into account the programmatic targets set for 2014-2015.
5. The Department has prepared "**Outcome Budget 2014-2015**" as per the extant guidelines issued by the Ministry of Finance, Department of Expenditure. The Table 2.1 annexed to Chapter II gives the Outcome Budget for 2014-2015 in the prescribed format.
6. The Department of Space is largely project and mission oriented. The nature of Outcome of the Space Programmes will be mainly in the form of (a) Indigenous capability to develop and realise complex space systems such as satellites and launch vehicles; (b) Creating infrastructure in Space by launching and operationalisation of satellites including Space operations, which are utilised by various user agencies for national development; (c) Capacity building in terms of critical technologies and ground technical infrastructure of relevance for future and (d) Benefits to the society arising from application of space technology/systems such as IRS satellites, INSAT satellites in various fronts. These have been appropriately reflected in the Table 2.1, Chapter II of the Outcome budget against various programmes/schemes.

7. The major programmatic targets for 2014-2015 are the following:-
- Launch and operationalisation of two satellites of Indian Regional Navigation Satellite System (IRNSS) i.e. IRNSS-1C and IRNSS-1D using Polar Satellite Launch Vehicle.
  - Launch of communication satellite GSAT-16 through procured launch services. The spacecraft will have 24 C-band, 12 Upper Ext-C band and 12 Ku-band transponders.
  - Experimental flight of next generation launch vehicle, GSLV-Mk III-X/Care Mission with passive cryo stage.
  - One commercial launch of Polar Satellite Launch Vehicle to launch French Remote Sensing Satellite, SPOT-7
  - Progress in other ongoing projects viz., GSLV Mk III, Semi cryogenic engine development, INSAT-3 & 4 satellites, Chandrayaan-2, Aditya-1 and ASTROSAT, GISAT and Small satellites for Atmospheric studies;
8. The Department has five Grant-in-aid Institutions under its fold viz., Physical Research Laboratory, National Atmospheric Research Laboratory, Semi-conductor Laboratory, North-East Space Applications Centre and Indian Institute of Space Science and Technology. A review of the performance of these institutions is presented in Chapter VI.
9. The Department has taken several policy initiatives and pro-active measures to enhance the effectiveness and outreach of the Space programme. The Policy framework of the Department encompasses the areas of Satellite Communications, Remote Sensing Data distribution, Industry participation, Commercialization, Human Resource Development, Extra-mural research, International Co-operation, effective user participation and continuous upgradation of technological capabilities. Societal applications has been a thrust area of the Space programme and the Department has initiated several programmes such as Tele-education, Tele-medicine, Village Resource Centres to take the benefits of space technology to the door-steps of common man.
10. Periodical review of the physical and financial performance of all the projects/schemes is an integral part of the planning and implementation strategy in DOS/ISRO. Quarterly targets are fixed for each major project/scheme during the beginning of the year and Additional Secretary & FA of the Department takes a rigorous review of the expenditure/commitment status on a monthly basis to ensure that the financial and programmatic targets are realized. With this, the Department has been able to meet most of the programmatic and financial targets.
11. The Indian Space Programme, over the years, has paved the way for creating cost-effective space infrastructure for the country in a self-reliant manner and the economic and social benefits brought in by the application of space technology to the national development have been significant. The Space Programme is poised to play a pivotal role in the national development in the coming years.

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## INTRODUCTION

1.1 The Indian Space Programme had a modest beginning with the launch of the first sounding rockets in November 1963 from the Thumba Equatorial Rocket Launching Station (TERLS), an obscure fishing village near Thiruvananthapuram for the investigation of ionosphere using sounding rockets. Further, the Indian Space Programme was institutionalized in November 1969 with the formation of Indian Space Research Organisation (ISRO). The Space programme got further fillip in June 1972, when the Government of India constituted the Space Commission and established the Department of Space (DOS). ISRO was also brought under the newly formed DOS in September 1972. Since then, over the last five decades, the ever challenging task of space technology development and utilisation, has not only graduated from experimental and demonstration phases to an operation era, but also provided its potential to address the national needs. Notable progress has been made in the design, development and operation of space systems, as well as, using them for vital services like telecommunications, television broadcasting, meteorology, disaster management support and natural resources survey and management including climate variability and change. The space programme has become largely self-reliant with capability to design and build satellites for providing space services and to launch them using indigenously designed and developed launch vehicles. The end-to-end capability in space for vital applications in communications, broadcasting, meteorology and natural resource information are of direct relevance for national development. The diverse roles of space technology & services in various fronts – social, economic, commercial and strategic have made the space systems an important component of our national infrastructure.

1.2 The primary objective of the Indian Space Programme has been to establish and operationalise space services in a self reliant manner in the thrust areas of Satellite Communication and Satellite based information for management of national services and Satellite Meteorological applications. The indigenous development of Satellites, launch vehicles and associated ground segment for providing these services, is integral to these objectives. With the establishment of the two major operational space systems – the Indian National Satellite (INSAT) for telecommunication, television broadcasting and meteorological services and management and the Indian Remote Sensing Satellite (IRS) for resource monitoring and management. With the establishment of these two major operational space systems, the Indian Space Programme has been providing operational services to the user community in the country. Two operational launch vehicles, Polar Satellite Launch Vehicle (PSLV) and Geo-synchronous Satellite Launch Vehicle (GSLV) provide self reliance in launching IRS and INSAT Satellites respectively.

## 2. Organisational Set-up

2.1 The Indian Space Programme has its genesis in the Indian National Committee for Space Research (INCOSPAR) that was formed by the Department of Atomic Energy in 1962. The Indian Space Research Organisation (ISRO) was established under the Department of Atomic Energy in August 1969. The Government of India passed a resolution in 1972 for setting up Space Commission and the Department of Space (DOS) to formulate and implement space policies in the country and brought the Indian Space Research Organisation (ISRO) under the Department of Space in September 1972.

2.2 The primary objective of DOS is to promote the development and application of Space Science and Technology for socio-economic benefit of the nation. The Indian Space Research Organisation (ISRO) is the research and development wing of the Department of Space and is responsible for executing the research and development programmes and schemes of the Department in accordance with the directives and policies laid down by the Space Commission and the DOS. The Space programme is executed through the ISRO Centre/ Units and its Grant-in-aid Institutions i.e., the Physical Research Laboratory (PRL), the National Atmospheric Research Laboratory (NARL), the North-Eastern Space Applications Centre (NE-SAC) and Semi-conductor Laboratory (SCL). The Antrix Corporation Limited (ACL), a wholly-owned Government Company established in 1992, is the apex marketing agency under DOS with access to resources of DOS as well as Indian Space industries. The establishment of space systems and their utilization are co-ordinated by national Committees, namely the INSAT Co-ordination Committee (ICC), the Planning Committee of National Natural Resources Management System (PC-NNRMS) and the Advisory Committee on Space Sciences (ADCOS). The ISRO Headquarters co-ordinates the overall programmes like launch vehicle, satellite communication, earth observation, space science, atmospheric science, space-industry development, disaster management support, international co-operation etc.

2.3 Following are the major Centres/Units of DOS/ISRO responsible for carrying out research and development activities as well as for undertaking the various projects and programmes:-

**A. Vikram Sarabhai Space Centre (VSSC)**

The Vikram Sarabhai Space Centre (VSSC) at Thumba, near Thiruvananthapuram, is the lead Centre for the development of satellite launch vehicles, sounding rockets and associated technologies. The Centre has developed expertise in aeronautics covering aerodynamics, flight mechanics, thermal analysis and structural engineering; mechanical engineering covering manufacturing technology, production and computer aided design; avionics covering control and guidance, TTC systems and on-board computers; propellants, polymers, chemicals, materials and metallurgy; propulsion and space ordnance; launch vehicle mechanism and launch vehicle design; composite materials and systems reliability. The Programme planning & evaluation, technology transfer & industrial co-ordination, human resources development, safety & personnel and general administration groups support the Centre. The Space Physics Laboratory (SPL) at VSSC carries out research in atmospheric and related space sciences. Apart from this, the Construction & Maintenance Group (CMG) carries out planning, execution and maintenance of all civil works related to the Centre.

VSSC has extension Centres at Valiamala, housing the major facilities of the Polar Satellite Launch Vehicle (PSLV) and the Geo-Synchronous Satellite Launch Vehicle (GSLV) Projects and at Vattiyoorkavu for the development of reinforced plastics and composites (Reinforced Plastics Facility). An Ammonium Perchlorate Experimental Plant (APEP) has been set up by VSSC at Aluva near Kochi. VSSC also supports the (i) Thumba Equatorial Rocket Launching Station (TERLS), the International sounding rocket range (ii) Rohini Sounding Rocket (RSR) Programme.

The major programmes at VSSC include: Polar Satellite Launch Vehicle (PSLV), Geosynchronous Satellite Launch Vehicle (GSLV), Rohini Sounding Rocket, Space-capsule Recovery Experiment, Reusable Launch Vehicles, Air Breathing Propulsion, Geo-Synchronous Satellite Launch Vehicle (GSLV) MK-III Development and development of critical technologies for Human Space Flight.

## **B. Liquid Propulsion Systems Centre (LPSC)**

The Liquid Propulsion System Centre (LPSC) with its facilities located at Thiruvananthapuram (Valiamala) and Bangalore is the lead Centre in the development of liquid and cryogenic propulsion stages for launch vehicles and satellites. In LPSC, Valiamala, Thiruvananthapuram management of system projects, design activities in the area of storable, cryogenic and semi cryogenic liquid propulsion systems, electric propulsion systems, flow control components and modules and spacecraft thrusters are carried out. In LPSC, Bangalore, spacecraft propulsion systems design, realization and integration, monopropellant thruster and component design, spacecraft propellant tank design and realization, managing production of propellant tank and structures for launch vehicles development and production of transducers are carried out.

## **C. ISRO Propulsion Complex (IPRC)**

The status of erstwhile LPSC, Mahendragiri has been elevated as “ISRO Propulsion Complex (IPRC)” with effect from February 1, 2014. IPRC has the responsibility for assembly, integration and testing of storable and cryogenic liquid rocket engines and stages, spacecraft thrusters testing in sea level and high altitude conditions, storage of liquid and cryogenic propellants and production of liquid hydrogen etc.

## **D. Satish Dhawan Space Centre-SHAR (SDSC-SHAR)**

The Satish Dhawan Space Centre (SDSC-SHAR) is the principal operational Centre for launching Sounding Rockets and Satellite Launch Vehicles. This Centre has the facilities for solid propellant processing, static testing of solid motors, launch vehicle integration and launch operations, range operations comprising telemetry tracking and command network and mission control centre. Management service group, Advanced Engineering Group, reliability and Sriharikota Common Facilities support the Centre. Apart from this, the Construction & Maintenance Division (CMD) takes care of planning, execution and maintenance of all civil works of the Centre. The Centre has two launch pads from where the rocket launching operations on PSLV & GSLV are carried out.

## **E. ISRO Satellite Centre (ISAC)**

The ISRO Satellite Centre (ISAC) at Bangalore is engaged in developing satellite technology and implementation of satellite systems for scientific, technological and application missions. ISAC is functionally organised into six major areas: Mechanical Systems Areas, Digital & Communications Area, Integration & checkout area, Power Systems & Avionics Production area, Control & Mission Area and Reliability & Components Area. The Construction & Maintenance Division (CMD) of the Centre is responsible for planning, execution and maintenance of all civil works related to the Centre.

Four project management teams co-ordinate the implementation of projects. Space astronomy and instrumentation division is engaged in space science activities. A new facility, ISRO Satellite Integration and Test Establishment (ISITE) including a Comprehensive Assembly, Test and Thermo-vacuum Chamber (CATVAC) has been set up recently.

## **F. Laboratory for Electro-Optics Systems (LEOS)**

The Laboratory for Electro-Optics Systems (LEOS) at Bangalore is responsible for design, development and production of electro-optic sensors like earth sensors, star sensors, sun sensors, magnetic sensors, temperature sensors and optical gyros for spacecraft use. LEOS is also responsible for the fabrication of various types of optics for satellite cameras & radiometers and development of indigenous detectors



for spacecraft. LEOS is also involved in the development of miniature sensors Micro Electro Mechanical Sensors (MEMS) devices, development of Charge Coupled Devices (CCD), Time Delay Integration (TDI) devices with external participation.

#### **G. Space Applications Centre (SAC)**

The Space Applications Centre (SAC) at Ahmedabad is responsible for the development, realization and qualification of communication, navigation, earth observation & meteorological payloads and related data processing and ground systems. The Centre carries out development of ground systems and application activities in the areas of communications, broadcasting, earth observations for remote sensing of natural resources, weather and environmental studies, disaster monitoring/mitigation, etc. SAC plays an important role in harnessing space technology for a wide variety of applications for societal benefits. The activities of SAC are grouped under microwave systems, satellite communication applications, sensor developments, image and information processing and remote sensing applications. Programme planning group, systems reliability group and library and documentation group support the Centre. The Construction & Maintenance Division (CMD) takes care of planning, execution and maintenance of all civil works related to the Centre.

The facilities of this Centre include the Ahmedabad Earth Station, the Delhi Earth Station, Portable & Mobile Earth Stations, Laboratories for remote sensing & communication activities, fabrication & environmental test facilities for development & qualification of space and ground hardware.

#### **H. Development and Educational Communication Unit (DECU)**

The Development and Educational Communication Unit (DECU) at Ahmedabad is involved in the conceptualisation, definition, planning, implementation and socio-economic evaluation of innovative developmental communications in space applications. The major current activities of DECU include: Training and Development Communication Channel (TDCC), Village Resource Centres (VRC), Tele-Health (TH), Tele-Education (TE) mission and new satellite communication development and applications.

#### **I. National Remote Sensing Centre (NRSC)**

National Remote Sensing Centre (NRSC) located at Hyderabad is responsible for satellite data acquisition, processing and dissemination of aeriels and remote sensing data. NRSC has set up data reception station at Shadnagar near Hyderabad for acquiring data from Indian remote sensing satellites as well as others. The Centre is also engaged in executing remote sensing application projects in collaboration with the users.

#### **J. Indian Institute of Remote Sensing (IIRS)**

Indian Institute of Remote Sensing (IIRS), Dehra Dun is a premier training and educational institute set up for developing trained professional in the field of Remote Sensing, Geoinformatics and GPS Technology for Natural Resources, Environmental and Disaster Management.

The main area of the function of the Institute is capacity building through technology transfer among user community, education at post-graduate level in the application of Remote Sensing & Geoinformatics for Natural Resources Management and promote research in Remote Sensing & Geoinformatics. The Institute provides value-added services in the field of natural resources management, remote sensing, GIS and GPS technology. Earlier, IIRS, Dehradun, was functioning under NRSC. With effect from April 30, 2011, IIRS has been re-organised as a separate Unit of ISRO.

## **K. ISRO Telemetry, Tracking & Command Network (ISTRAC)**

The ISRO Telemetry, Tracking & Command Network (ISTRAC) at Bangalore provides mission support to low-earth orbit satellites as well as for launch vehicle missions. ISTRAC has its headquarters and a multi-mission Spacecraft Control Centre at Bangalore. It has a network of ground stations at Bangalore, Lucknow, Sriharikota, Port Blair and Thiruvananthapuram in India besides stations at Mauritius, Bearslake (Russia), Brunei and Biak (Indonesia). ISTRAC activities are organised into network operations, network augmentation, mission operation and spacecraft health monitoring, communications & computers & control centre facilities and development projects. Programme planning and reliability groups support ISTRAC activities. ISTRAC also operates the Local User Terminal/Mission Control Centre (LUT/MCC) under the international programme for satellite aided search and rescue. An Indian Deep Space Tracking Network station at Byalalu near Bangalore for India's mission to moon, Chandrayaan-1, has been recently established by ISTRAC.

## **L. Master Control Facility (MCF)**

The Master Control Facility (MCF) located at Hassan in Karnataka and Bhopal in Madhya Pradesh monitors and controls all the geo-stationary satellites of ISRO. MCF carries out operations related to initial orbit raising of satellites, in-orbit payload testing and on-orbit operations through out the life of the satellites. The operations involve continuous tracking, telemetry and commanding, special operations like eclipse management, station-keeping maneuvers and recovery in case of contingencies. MCF interacts with the user agencies for effective utilisation of the satellite payloads and to minimize the service disturbances during special operations.

## **M. ISRO Inertial Systems Unit (IISU)**

The ISRO Inertial Systems Unit (IISU) situated at Vattiyoorkavu, Thiruvananthapuram carries out research and development in inertial sensors, inertial systems, navigational software, actuators & mechanisms and to realize the flight units of these system for the launch vehicle & satellite programmes and allied satellite elements. IISU is organised into research and development divisions in the areas of launch vehicle inertial systems, spacecraft inertial systems, inertial system production and reliability & quality assurance. It has facilities for precision fabrication, assembly, clean room and integration & testing.

2.4 A National Natural Resources Management System (NNRMS) with the Department of Space (DOS) as the nodal agency has been established to ensure optimal management/utilisation of natural resources using remote sensing data in conjunction with conventional techniques.

2.5 Following are the Grant-in-aid institutions of DOS:-

### **A. Physical Research Laboratory (PRL)**

The Physical Research Laboratory (PRL) at Ahmedabad, is an autonomous institution funded by DOS through grant-in-aid. It is a premier institute engaged in basic research in experimental & theoretical physics and earth sciences. PRL is also responsible for the administration of the Udaipur Solar Observatory. Research activities in the area of infrared astronomy, solar and plasma astrophysics, solar and galactic astronomy, geo-cosmo physics, planetary atmosphere, solar-terrestrial physics, laboratory astrophysics, theoretical physics and archaeology & hydrology are carried out at PRL. PRL is also involved in conducting extensive academic programmes for Doctoral and Post Doctoral research and also has an Associateship programme for University Teachers.

## **B. National Atmospheric Research Laboratory (NARL)**

The National Atmospheric Research Laboratory (NARL) at Gadanki near Tirupati is an autonomous research laboratory fully funded by DOS. The main objectives of NARL are (i) Basic research in atmospheric science (ii) Indigenous technology development for probing the atmosphere and (iii) Application of Weather and Climate research for short and long term weather prediction. NARL has a variety of state-of-the-art equipments such as the Mesosphere-Stratosphere-Troposphere (MST) Radar, different types of LIDARs, regular GPS sonde balloon launches, automatic weather station etc. NARL is available for national and international scientists to conduct research in atmospheric & space sciences and related disciplines.

## **C. North-Eastern Space Applications Centre (NE-SAC)**

The North-Eastern Space Applications Centre (NE-SAC) located at Shillong set up as an autonomous society jointly with the North-Eastern Council, is supporting the North-Eastern Region by providing information on natural resources utilisation & monitoring, infrastructure developmental planning & interactive training using space technology inputs of remote sensing & satellite communication. The Centre has the mandate to develop high technology infrastructure support to enable NE states to adopt space technology inputs for their development. At present, NE-SAC is providing developmental support by undertaking specific projects, utilising space technology inputs in remote sensing, satellite communication and space science.

## **D. Semi-conductor Laboratory (SCL)**

The SCL is engaged in the design, development and manufacture of Very Large Scale Integrated Circuits (VLSIs) and development of systems for telecommunication & space sectors Board Level Products. The SCL has an Integrated Facility comprising class 10, 6" Wafer Fabrication Plant, Design Facility, Test & Assembly, Quality Assurance & Reliability and system Level Assembly Facility. Development & Manufacture of ASICs for Strategic Sector is the major thrust.

## **E. Indian Institute of Space Science & Technology (IIST)**

The Indian Institute of Space Science and Technology (IIST) is an autonomous body under DOS formed with the primary objective of creating world class Institution in the area of advanced Space Science and Technology education and generating high quality human resources to meet the quality human resource requirements of DOS/ISRO. The Institute has undergraduate, postgraduate and doctoral programmes in the area of space science technology and applications. The Institute offers graduate, post-graduate and doctoral programmes in the area of Space Science and Technology. The Institute has started functioning from the academic year 2007-2008, around the existing infrastructure adjacent to VSSC, Thiruvananthapuram. It started functioning from its own new campus at Valiamala from August 15, 2010. The annual intake of the Institute is about 150-200 students. Three batches of fresh graduates from the Institute have been inducted to various DOS/ISRO Centres/Units.

2.6 A part from this, the RESPOND programme of ISRO supports sponsored research activity in Space Science, Space Applications and Space Technology in various national academic/research institutions and Space Technology Cells in premier technological institutes of the country through grants-in-aid. The RESPOND Programme is aimed at promoting space research activities and to develop a large research based trained manpower and infrastructure facilities for specific activities of interest to the space programme in the country.

## **2.7 Antrix Corporation Limited (ACL)**

The Antrix Corporation Limited, Bangalore is the marketing agency under DOS with access to resources of DOS as well as Indian space industries. Antrix markets subsystems and components for satellites, undertakes contracts for building satellites to user specifications, provides launch services and tracking facilities and organizes training of manpower and software development.

## **3. Major projects/programmes of Department of Space**

3.1 The Department of Space (DOS) has the primary objective of promoting development and application of Space Science and Technology to assist in all-round development of the nation. Towards this, the Department has evolved the following programmes:-

- (a) Launch Vehicle programme having indigenous capability for launching spacecrafts;
- (b) INSAT Programme for telecommunications, broadcasting, meteorology, development of education etc;
- (c) Remote Sensing Programme for application of satellite imagery for various developmental purposes; and
- (d) Research and Development in Space Science, Technology for subserving the end of applying them for national development.

3.2 Over the years, India has established two operational Space Systems - the Indian National Satellite (INSAT) System providing services for telecommunications, TV broadcasting and meteorology including disaster warning support and the Indian Remote Sensing Satellite (IRS) System for natural resource monitoring and management. The Polar Satellite Launch Vehicle (PSLV) is well proven through Twenty Five successive successful flights and has emerged as a reliable cost-effective launch vehicle. The successful launch of two developmental flights of Geosynchronous Satellite Launch Vehicle, GSLV-D1 & D2 in 2001 & 2003, followed by first operational flight in 2004 and launch of GSLV-F04 carrying INSAT-4CR launched in 2007 was a major achievement in the Indian Space Programme. However, there were failures of 2 Geo-synchronous Satellite Launch Vehicle (GSLV) flights viz. GSLV-D3 with Indigenous Cryogenic Stage during April, 2010 and GSLV-F06 with Russian Cryogenic Stage during December, 2010. Flight testing of Indigenous Cryogenic Engine and Stage was successfully carried out on-board GSLV-D5 on January 5, 2014.

3.3 Indian Earth Observation satellite system is one of the largest constellations of remote sensing and meteorological satellites in operation in the world today. With currently thirteen operational satellites in orbit viz. CARTOSAT-1, CARTOSAT-2, CARTOSAT-2A, CARTOSAT-2B, RISAT-1, RISAT-2, OCEANSAT-2, RESOURCESAT-2, SARAL and MEGHA-TROPIQUES, INSAT-3A, INSAT-3D and KALPANA-I which provide data in a variety of spatial, spectral and temporal resolutions. They serve as main stay of the National Natural Resources Management System (NNRMS) besides providing data worldwide. Vital applications such as identifying zones which could yield ground water, suitable locations for recharging water, monitoring command areas, estimating crop areas and yields, assessing deforestation, mapping urban areas for planning purposes, delineating ocean areas with higher fish catch potential, monitoring of environment and scene specific spot imagery are being pursued actively by users with the space based data. The data from IRS Satellites is received worldwide through a network of International ground stations under commercial agreement with M/s. Antrix.

3.4 INSAT contributes significantly to a variety of services in telecommunications and television broadcasting including meteorological observations, disaster communications, Tele-education and Tele-health services. Indian National Satellite (INSAT) system is a joint venture of the Department of Space, Department of Telecommunications, India Meteorological Department, All India Radio and Doordarshan. Established in 1983, INSAT is the largest domestic communication satellite systems in the Asia Pacific Region with ten satellites in operation –INSAT-3A, INSAT-3C, INSAT-4A, INSAT-4B, INSAT-4CR, GSAT-8, GSAT-7, GSAT-10, GSAT-12 and GSAT-14. The overall coordination and management of INSAT system rests with the INSAT Coordination Committee (ICC).

3.5 Front ranking scientific investigations are being carried out in the fields of astronomy, atmospheric sciences, planetary science and long term climatic research using satellites, balloons, sounding rockets & ground instruments. India's first mission to moon, Chandrayaan-1 was successfully launched on October 22, 2008 on-board the PSLV C-11. The payloads of Chandrayaan-1 have sent useful scientific data about Moon. The data collected from various payloads of Chandrayaan-1 were analysed by world wide scientists. Development of a multi-wave length astronomy satellite ASTROSAT and India's second mission to moon, Chandrayaan-2 have also been taken up.

3.6 India's first Mission to Planet Mars, Mars Orbiter Mission was successfully launched on November 05, 2013. Subsequently, the Mars Orbiter Spacecraft was injected to Mars transfer trajectory through critical orbit manoeuvres on December 01, 2013. The Spacecraft has now crossed half way mark of its long journey to the Red Planet along the designated Helio-centric trajectory on April 09, 2014. Mars Orbit Insertion (MOI) manoeuvre is planned on September 24, 2014.

3.7 The Indian Space programme has enabled a significant role for national industries in realisation of space systems. A strong bond with academic institutions exists through extensive research partnership. Unique organisational systems have been evolved in the national space programme for fulfilling diverse functions like development, operations and applications of complex space systems. The space programme has enabled significant technology growth in multiple disciplines as spin-off benefits.

3.8 Indian capabilities in space thus represent a wide spectrum of expertise ranging from the conceptual design to building and operating a variety of space systems, which are matched only by a few nations in the world. In view of these multiple dimensions and capabilities, India is recognised as a leader in space applications that have a wide impact on society.

#### **4. Overview of Twelfth Five Year Plan 2012-2017**

4.1 During the 12th Plan, the thrust of the space programme will be on augmentation INSAT/GSAT capacity to meet demand for transponders, establishment of the Indian Regional Navigational Satellite System over Indian region, continuation of established services with improved capabilities with thematic series of Indian EO satellites, expansion of satellite based applications including societal applications, strengthening of Polar satellite Launch Vehicle (PSLV) and Geo-synchronous Launch Vehicle (GSLV) as the workhorse vehicle, Realisation of developmental flights of next generation launch vehicle (GSLV MK III) capable of launching 4T class INSAT satellites; pursuance of semi-cryo engine development, undertaking space science and planetary exploration; strengthening space-based Disaster Management Support and developing critical technologies for the human spaceflight programme.



4.2 In the area of **Satellite Communications**, it has been planned to augment the INSAT capacity to bridge the gap between the demand and supply of the transponders for meeting all the requirements of the country and also to maintain sufficient spares capacity to meet contingencies. Development of state-of-the-art technologies and latest applications areas shall also be pursued.

4.3 The demand to be met for Transponders by end of 12<sup>th</sup> Five Year Plan is estimated to be ~ 400. In order to meet the emerging demand for operational transponder, 14 communication satellites are planned to be realised during the 12<sup>th</sup> Plan period for (a) increasing the transponder capacity (b) introducing new generation broadband VSAT systems (c) introduction of Ka band systems (d) building high power S-band satellite mobile communications and (e) introduction of new generation geo-imaging satellite

4.4 In terms of spacecraft platforms, it is planned adopt I-2K, I-3K and I-4K buses for the communication satellites. I-3K and I-4K buses are planned to be launched using procured foreign launcher. It is also planned to initiate development of High throughput I-6K – 12KW bus in higher frequency bands like Ka/Ku and the technologies associated with it.

4.5 Maintaining and securing sufficient orbit-spectrum resources for country's Satcom activities will be a thrust area of 12th Plan. It has been planned to pursue rigorously to secure spectrum for 100 additional Ku-band transponders and around 50 C-band/Ext C-band transponders in newer orbital locations.

4.6 **Satellite based Navigation** service is an emerging satellite based system with commercial and applications. Establishment of an independent Indian Regional Navigation Satellite System (IRNSS) over Indian region with a constellation of 7 satellites was planned to be realised during the 11th Plan. Considerable progress has been achieved in realizing the various subsystems of these satellites and the constellation shall be completed during the 12th Plan. Implementation of the final operational phase for satellite based augmentation system (SBAS) GAGAN (GPS Aided Geo Augmented Navigation) over the Indian Airspace is also an important targets for 12th Plan. Formulation of Indian Satellite Navigation Policy to facilitate growth of Satellite based navigation application will also be pursued. Work towards augmentation of IRNSS system with 4 additional satellites shall also be initiated during the 12th Plan.

4.7 The thrust areas of **Earth Observation and Atmospheric Sciences Programme** for the 12th Plan will be in continuation of established services with improved capabilities with three thematic series of Indian EO satellites i.e. Natural resources, Cartography and Ocean & Atmosphere, including all-weather capability; development of newer state-of-the-art capabilities to meet specific user requirements; augmentation of ground segments for effective utilization of the various sensors; and special emphasis application missions in the areas of agriculture, environment, large scale mapping, infrastructure planning, oceanography, climate and atmospheric studies. To achieve the above, 8 Earth Observation missions are planned during the 12th Five Year Plan period. With the realization of these missions, there would be significant improvements in the areas of short term weather and ocean state forecasting, natural resources management, high resolution cartography, large scale mapping, space based Essential Climate Variables (ECVs) with enhanced spatial, spectral, radiometric and temporal resolution.

4.8 **The Disaster Management Support (DMS) Programme** of ISRO is intended to provide near real time information support and services from imaging and communication satellites towards efficient management of disasters in the country. Major programmatic targets of DMS programme during 12th Five Year Plan period will be Operationalization of National Database for Emergency Management (NDEM), Continuation of impact mapping and monitoring of natural disasters with improved turnaround time and

with newer capabilities, acquisition of close contour data through ALTM, extension of the communication network to the District Emergency Operation centres, geo-location based services such as Search & Rescue and distress alerts, operational dissemination of the information and products directly to the affected areas, Operational utilization of early warning systems and extension of the Hydro-meteorological network.

4.9 The main focus of the **Space Transportation Systems** during 12th plan period will be towards achieving self-sufficiency in launching our satellites, developing launch vehicles for enhanced payload capability, adopting appropriate outsourcing strategies for assuring productionisation of launch vehicles, enhancement of infrastructure for launch vehicles and developing advanced technologies for the future. Towards this, enhancement of level of production of PSLV Vehicle systems with vigorous industry participation, completion of qualification of indigenous Cryogenic Upper Stage (CUS), proving GSLV with indigenous cryogenic stage, as a reliable workhorse launch vehicle, Completion of development and qualification of C25 Engine & Stage, completion of one development flight of GSLV Mk III with 4.0 T GTO capability, progress on the development of Semi cryogenic engine with the establishment of test facilities, augmentation spaceport infrastructure to meet the launch vehicle requirements shall be pursued. During the 12th Plan period, 17 PSLV missions, 6 GSLV MK-II missions and 2 GSLV MK-III missions (including one experimental mission) are planned to be accomplished.

4.10 **Space Sciences & Planetary Exploration** missions contribute significantly towards understanding the mysteries of the universe, our existence and provide an opportunity towards development of cutting edge technologies. Through space science investigations, we seek to understand the processes governing solar radiation, evolution of planetary system, formation of galaxies, evolution of stellar systems and the universe. Missions initiated during the 11th Plan such as Chandrayaan-2, Astrosat-1 and Aditya-1 will be realised in 12th plan. Undertaking India's First Mission to Mars, Mars Orbiter Mission will be an important milestone during the 12th Plan. In addition, an X-Ray polarimeter (POLIX) to study the x-ray polarization from bright x-ray emitting objects shall also be pursued.

4.11 Technological advancement, which is essential to maintain competitive relevance, will be an important thrust area for future space endeavors. The current level of technologies have to be upgraded to a higher magnitude and novel concepts have to be developed in order to achieve a much better and reliable space system. New technologies acquired will be the driving force for futuristic space missions. Towards this the following technological development activities are planned during the 12th plan period.

4.12 In the area of Launch Vehicle technology development, critical technology initiatives such as composite segmented booster case for large solid motors, elastic memory composites and Carbon-carbon technology demonstrators including optimization studies of carbon-carbon processing through CVI furnace, Robotics for planetary missions, Nano materials and composite, lunar soft lander etc., shall be pursued. Similarly, in the area of Satellite Technology development of Green House Gases and Trace gases sensors using hyperfine and ultrafine spectrometers, Field based multi-frequency microwave Ground Penetrating Radar, Reflective Optics with large diameter mirrors, Advance SiC Mirror technology for 2 to 2.5 M Optics, CFRP and composite based telescope/antenna structures, higher capacity Lithium ion batteries, Electric propulsion along with chemical propulsion, miniaturization – MMICs, ASICs, FPGAs, HMCs, BGAs based systems, I-6K Unified bus with modular design, multi EV panels and scalable structure (Bus module & payload module), Inter-satellite communication links, Multi-channel Waveguide Rotary Joint, Development of Portable Ku-band Tele-medicine Terminal, Satcom based Automatic Identification System (AIS), development of Indigenous Space qualified atomic clocks & On-board time synchronization technology shall be initiated.

4.13 In order to demonstrate emerging new technology developments, a series of experimental satellites have been planned. One of the major missions being the technology demonstration related to Docking and Rendezvous. These satellites will be flown on the PSLV missions as auxiliary or co-passenger satellites.

4.14 In addition, policy initiatives such as New Satcom Policy, Space Legislation, Space Navigation policy etc., shall be put in place to facilitate the growth and development of Space Science and Technology in the country.

4.15 Few specialized technical facilities for supporting the development, fabrication, integration and testing of the satellite systems and launch vehicles systems as well as launch and mission management have been planned during the 12th Plan period. The critical facilities considered amongst others during the 12th plan include establishment of Third Launch Pad at Sriharikota to support the increased launch frequency of PSLV, GSLV, Multiple Object Tracking Radar for tracking the space debris to safeguard our space assets, Second Vehicle Assembly Building to improve the launch turn around, Second Cryogenic Main Engine and Stage Test facility at IPRC, Mahendragiri, solar cell production facility to minimizing the dependency for solar cell from foreign sources and setting up of Space Technology Parks at different locations to facilitate industry participation in Indian Space Programme.

4.16 Overall, 58 missions are planned for realisation during 12th Plan period which includes 33 Satellite missions and 25 Launch Vehicle missions.

4.17 The Plan Outlay for the missions planned for the 12<sup>th</sup> Plan period as well as the advance investments required for the missions planned for the early phase of 12<sup>th</sup> Plan, has been indicated to be ₹ 39,750.00 Cr. The non-plan budgetary support during 12th Plan is expected to be ₹ 7,500 crores approx.

4.18 The Indian Space Programme has paved the way for creating cost-effective space infrastructure for the country in a self-reliant manner and the economic and social benefits brought in by the application of space technology to the national development have been significant. The Space Programme is poised to play a pivotal role in the national development in the forthcoming decade.

## **5. Mandate of the Department of Space**

5.1 The Department of Space is committed to:-

- (I) provide national space infrastructure for the telecommunication needs of the country, including the required transponders and associated ground systems;
- (II) provide satellite data required for weather forecasting, monitoring etc;
- (III) provide satellite imagery and specific products and services required for application of space technology for natural resource management/developmental purposes to the Central Government, State Governments, Quasi Governmental Organisations, NGOs and the private sector;
- (IV) Promote Research & Development in space sciences and technology;



## 6. Policy framework of Department of Space

6.1 The Indian Space Programme is directed towards development and utilization of space science and technology in a self-reliant manner for the social-economic development of the country. Taking cognizance of the global space competitiveness, the policy framework of the Space programme envisages:

- (a) **Industry Participation Policy** to promote participation of Indian Industries in the national space endeavors - higher levels of aggregates in system/stage level supply from the industry, use of ISRO facilities by Industry, technology transfer to the industry and technical consultancy services of ISRO expertise.
- (b) **Commercialisation Policy** to extend the outreach of Indian Space assets, products and services to the global market through Antrix Corporation, Dissemination of IRS data through International ground stations on commercial basis, Leasing of INSAT transponders to private users, launching of foreign satellites by Indian Launch Vehicles (PSLV/GSLV), TTC support for foreign satellites, design and development of communication satellite for International customers.
- (c) **Remote Sensing Data Policy** for acquisition and distribution of satellite remote sensing data from Indian and foreign satellites for civilian users in India.
- (d) **Satcom Policy** to enable use of INSAT satellites by non-government sectors and to establish and operate private communication satellite.
- (e) **International Co-operation Policy** for mutual benefit – bilateral and multilateral co-operative programmes, payloads of opportunity to be flown onboard Indian satellites and participation in international forums.
- (f) **Human Resource Development Policy** oriented to retain the critical mass, training and development programmes, rewards and incentives, flexibility in career growth prospects, sabbatical opportunities and capacity creation in the academia through sponsored research.
- (g) **Effective user participation** in the space systems planning and utilization – establishment of inter-departmental/inter-ministerial co-ordination mechanisms viz., INSAT Co-ordination Committee (ICC), Planning Committee of National Natural Resource Management System (PC-NNRMS) and Advisory Committee on Space Sciences (ADCOS).
- (h) **Upgrading the technological capabilities** to realise state-of-art cost effective space systems viz., satellites, launch vehicles and associated ground systems for providing national space services.

The above policy framework has paved the way for creating cost effective space infrastructure for the country in a self-reliant manner, its efficient utilisation for national development, enabled a significant role for Indian Industries and technology growth in multiple disciplines as spinoff benefits.

\* \* \* \* \*

## OUTCOME BUDGET 2014-15

1.1 The Budget proposals for the Department of Space have been formulated under the framework of Decade Profile 2010-2020 and the missions planned for Twelfth Five Year plan (2012-2017). The BE 2014-15 for Department of Space stands at ₹ **7238.04** crore comprising of ₹ **6000.04** crore 'Plan' outlay and ₹ **1238.00** crore 'Non-plan' outlay. The outlay has been arrived at taking into account the Programmatic targets set for 2014-2015.

1.2 The Department has prepared "**Outcome Budget 2014-15**" based on the guidelines contained on the subject in the Department of Expenditure, Ministry of Finance Office Memorandum No. 10(3)/E.Cord/2012 dated January 01, 2013. The Table 2.1 annexed to this Chapter, gives the Outcome Budget for 2014-2015.

1.3 Table 2.1 has been organised as per the Statement of Budget Estimates (SBE) submitted by the Department. However, the order in which various Schemes/Project appear, has been slightly modified in Outcome budget (as compared to SBE) with a view to bring related projects together. For example, under Launch Vehicle Technology, GSLV Operational Project has been brought immediately after GSLV Project in order to bring all GSLV related Projects together.

### 2. Projects / Mission Mode Working

The Department of Space is largely project and mission oriented. The Department undertakes specific projects and programmes (viz., development of Satellites, launch vehicles and applications) based on demand for space services and executes them in a time-bound manner. Once the objectives of the project are achieved, the project is closed and the resources are re-deployed for other ongoing projects. The Missions and Projects are executed by the Centres and Units of ISRO under matrix management structure to ensure optimum utilization of resources. The Centres and Units are fixed entities and are the custodians of resources in terms of technology, infrastructure and human resources required for execution of the project.

### 3. Intermediate Outputs:

The implementation of projects on development of satellites, launch vehicles and the associated ground systems is a multi-disciplinary and multi-institutional endeavour. The ISRO Centres/Units are organised based on their areas of specialisation/expertise. For launch vehicle projects, Vikram Sarabhai Space Centre is the lead centre while for Satellite Projects, ISRO Satellite Centre is the lead centre. The lead centre of the project will have the primary responsibility for overall design, subsystem interface specifications, project management and co-ordination in addition to development of subsystems for which the lead centre has specialisation. The other Centres/Units of ISRO will have the responsibility to realise specific subsystems / sub-assemblies for the project in the area of their expertise / specialisation. Therefore, the output of the ISRO Centres / Units (other than the lead centre), related to realisation of sub-systems for satellites and launch vehicles, are of intermediate products in nature, which will get integrated with the work of lead Centre. This has been suitably reflected in the Outcome budget.

#### **4. Partial Outcome :**

The gestation period for Space Projects i.e., Development of Satellites, Launch vehicles and associated ground segments is generally 3 to 5 years, while in some complex projects, it could extend up to 8 – 10 years also. In the course of the development, the Project goes through various phases such as finalisation of configuration and detailed design, engineering & proto models development and qualification testing, fabrication of flight subsystem units and testing, assembly, integration and testing leading to launching of the satellite into orbit. The Output and Outcome of a Satellite or launch vehicle project during a year is a result of accumulated expenditure on the projects during the previous years. Similarly, the outlay of a Satellite or launch vehicle project during a year does not necessarily result in output or outcome in the same year. While the deliverables and physical outputs are targeted and specified for each year for every project based on the development /realisation plans, the final outcome will accrue only upon the launch and operationalisation of the satellite. The time frame for such final outcomes are also specified in the Outcome budget. Therefore, for the Projects which are in initial or intermediate stage, the partial outcome can be viewed as almost same as the Physical Output. However, the time frame for the final outcome is also specified in the Outcome budget.

#### **5. Converting Outputs to Outcomes:**

The Outcome of a programme is largely dependent on the Objectives of the Programme. The primary objective of Space Programme is to develop the Space Technology (comprising of development of Satellites, Launch Vehicles and associated Ground segments), establish operational space systems in a self-reliant manner and demonstrate through pilot projects the potential applications of Space systems for national development in the areas such as Natural Resource Management, Tele-communications, TV broadcasting, developmental communications, rural communications, Tele-education, Tele-medicine and Disaster Management support. Therefore, the nature of Outcome of the Space Programmes will be in the form of (a) Indigenous capability to develop and realise complex space systems such as satellites and launch vehicles (b) Creating infrastructure in Space by launching and operationalisation of satellites including Space operations, which are utilised by various user agencies for national development (c) Capacity building in terms of critical technologies and ground technical infrastructure of relevance for future and (d) Benefits to the society arising from application of space technology / systems such as IRS satellites, INSAT satellites in various fronts. These have been appropriately reflected in the Outcome budget against various programmes/ schemes.

\* \* \* \* \*

# Department of Space

TABLE-2.1

## OUTCOME BUDGET 2014-2015

(₹ in Crores)										
Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	(4ii)	4(iii)	5	6	7	8
LAUNCH VEHICLE TECHNOLOGY										
1	Geo-synchronous Satellite Launch Vehicle (GSLV)	Develop a launch vehicle to launch 2 Ton class INSAT satellite into Geosynchronous Transfer Orbit (GTO) through three developmental flights.		---	---	---	Realisation and integration of stages of GSLV-D6 flight.	Self-reliance in launching 2T class of communication satellites.	Launch of GSLV-D6 with indigenous Cryo stages planned in June 2015	GSLV D1 and D2 have been successfully launched during 2001 and 2003. GSLV-D3 was launched in 2010 but was unsuccessful. Launch of GSLV-D5 flight with indigenous cryogenic stage was successfully carried out on January 5, 2014.  Funding required for GSLV D6 is being met from GSLV-Operational programme. Hence, no provision is shown in the current year.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15				Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR					
1	2	3	4	4(i)	(4ii)	4(iii)		5	6	7	8
<b>LAUNCH VEHICLE TECHNOLOGY</b>											
2	Cryogenic Upper Stage Project (CUSP)	Development of a restartable cryogenic engine & stage for GSLV to replace the Russian supplied Cryogenic stage of GSLV	335.89	---	0.10	---		Delivery and integration of the Indigenous cryo stage with the launch vehicle.	Achieve self reliance in launching 2T class INSAT type of satellites.	Launch of GSLV-D6 with indigenous Cryo stages planned in June 2015	Indigenous cryogenic stage was successfully flight tested on-board GSLV-D5 on January 5, 2014.
3	GSLV Operational	To fabricate 16 operational GSLV launch vehicles (GSLV F1 - F16) and take advance procurement actions for additional vehicles and launch communication satellites.	3550.96	---	203.67	---		Realisation of subsystems for solid and liquid and cryo stages of GSLV-F07 mission.	Augmenting INSAT system with additional transponders to meet the communication requirements.	GSLV-F07 mission planned during 2015.	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	(4ii)	4(iii)	5	6	7	8
LAUNCH VEHICLE TECHNOLOGY										
4	GSLV Mk III Development	To develop a Geosynchronous launch vehicle capable of launching 4Ton class INSAT type of satellites to GTO.	2962.78	---	180.10	---	Readiness of S200 & L110 flight stages  Readiness of passive C25 stage for flight testing.  Completion of qualification tests and Mission simulation tests  Launch campaign & launch of GSLV Mk III Experimental flight.  C25 Engine tests, C25 development stage realization & S200 ST03 static test	Partial Outcome: Realisation of technical facilities and development hardware required for GSLV Mk III. The project is currently in intermediate stage. The final outcome of achieving self reliance in launching 4T class of INSAT satellites will accrue upon successful flight testing of GSLV Mk III vehicle.	GSLV-Mk III Experimental flight targeted for 2014-15.	GSLV Mk III will have the capability to launch 4T class of communication satellite into Geosynchronous Transfer Orbit.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	(4ii)	4(iii)	5	6	7	8
LAUNCH VEHICLE TECHNOLOGY										
5	PSLV-Continuation Project	To fabricate Operational Polar Satellite Launch Vehicles (PSLVs) for launching Remote Sensing and Scientific satellites.	1518.00	---	390.00	---	Mission planning, final vehicle Assembly, Testing and Launch of C23, C24, C26, C27 & C28 to launch 3 IRNSS satellites ASTROSAT & one foreign satellite.	Launch of 3 Navigational satellites-IRNSS-1B, 1C & 1D to build a constellation of satellites for Indian Regional Navigational Services.  Launch of a foreign satellite on commercial basis and launch of ASTROSAT.	Five operational flights of PSLV are planned during 2014-15.	PSLV had so far 25 successive successful flights and has emerged as a versatile, reliable and cost-effective launch vehicle. Its launch capability has been progressively enhanced from 850 kgs to 1750 kg through continuous improvements in the launch vehicle.
6	Space Capsule Recovery Experiment (SRE-1& 2)	Develop a recovery capsule and demonstrate the technology for recovery and conduct micro-gravity experiments through two flights viz., SRE-1 & 2.	76.20	---	0.25	---	Final Assembly, Integration and testing of SRE-II	Validation of re-entry technology	SRE-2 will be launched as a co-passenger in PSLV.	SRE-1 was successfully launched on 10th January 2007 onboard PSLV C7 and recovered on 22nd January 2007. This unique mission has demonstrated the capability to recover a satellite from orbit at a predetermined location and the associated technologies.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	(4ii)	4(iii)	5	6	7	8
<b>LAUNCH VEHICLE TECHNOLOGY</b>										
7	Vikram Sarabhai Space Centre (VSSC)	To develop critical and advanced technologies related to satellite launch vehicles including Reusable Launch Vehicles (RLV), Sounding rockets and allied satellite subsystems and provide infrastructure support for development and fabrication / testing of Indian launch vehicles.	N.A	296.66	692.01	---	Realisation of subsystems for five PSLVs missions (PSLV C23, C24, C26, C27 & C28), one GSLV mission (GSLV- D6) and the first experimental flight of GSLV MKIII mission (LVM3-X mission) and Re-usable Launch Vehicle (RLV HEX-01).  Commissioning of Sodium Chlorate Facy at TCC, Kochi. Infrastructure build-up towards testing /characterisation of materials and systems.  Activities to strengthen Technology Development and Productionisation efforts in the area of avionics, aeronautics, advanced materials, propulsion systems, mechanisms, control & guidance and manufacturing technology for increased launch requirements.	Technology development initiatives and hardware development and realisation lead to state-of-the-art launch vehicles for Indian Space Programme.	Continuing efforts in technology and hardware development to remain state of the art in launch vehicle and satellite technology for Indian space programme.	



Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	(4ii)	4(iii)	5	6	7	8
<b>LAUNCH VEHICLE TECHNOLOGY</b>										
8	ISRO Inertial Systems Unit. (IISU)	Research, Development and realisation of inertial sensors and systems for launch vehicles and allied satellite elements.	NA	---	76.88	---	<p>Delivery of flight and flight standby systems of RESINS and GAINS for five PSLVs and one GSLV missions.</p> <p>Realization of inertial systems for 7 satellite missions.</p> <p>Procurement of major equipment such as Ultra High Precision CNC Turning Centre, High Precision CNC Machining Centre, Vibration Shaker System, Thermo Vacuum Chambers and Precision Centrifuge.</p>	<p>Realisation of tested and qualified inertial systems such as Inertial Navigation systems, Servo Accelerometers, Mission management unit, Momentum Wheels, Reaction Wheels, Solar Array Drive Assembly, Gyros, inertial reference units, scan mechanisms, etc., for Launch Vehicles and Satellites.</p> <p>Inertial systems are intermediate products / subsystems used in satellites and launch vehicles.</p>	<p>Technology development, improvement and scaling up is a continuous process to remain state-of-the-art in satellite and launch vehicle technology and to achieve maximum self-reliance in this strategic area.</p>	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan						
				4(i)	(4ii)	4(iii)				
1	2	3	4	68.05	210.00	---	5	6	7	8
LAUNCH VEHICLE TECHNOLOGY										
9	Liquid Propulsion Systems Unit (LPSC)	Development of earth storable liquid propulsion and cryogenic propulsion technology/ systems for launch vehicles and satellites.	NA	68.05	210.00	---	Delivery of integrated propulsion system for satellite missions.  Integration & delivery of flight worthy cryogenic upper stages for GSLV Mk2 mission.  Realisation of propellant tank and structure for C25 Stage for ground test. Flight test of L110 stage in LVM 3 X flight.  Hardware realisation and delivery of PS2, PS4 stages and control power plants for PSLV.  Realisation of GS2 stages, L40 stages and CUS for GSLV. Delivery of SITVC & RCS systems for RLV HEX-01 mission	Realisation of tested and qualified (a) liquid and cryogenic stages for PSLV and (b) Reaction control systems for IRS and GEOSAT Satellites.  Liquid and Cryogenic propulsion systems are intermediate products / subsystems used in satellites and launch vehicles.	Technology development, improvement and scaling up is a continuous process to remain state-of-the-art in satellite and launch vehicle technology and to achieve maximum self-reliance in this strategic area.	Liquid Propulsion Systems Centre is the lead centre for development of liquid and cryogenic propulsion systems and has established unique technical infrastructure (test and fabrication facilities) at Mahendragiri, Valiamala and Bangalore.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	(4ii)	4(iii)	5	6	7	8
<b>LAUNCH VEHICLE TECHNOLOGY</b>										
10	ISRO Propulsion Complex (IPRC)	Assembly and Testing of storable and cryogenic and liquid Rocket Engines and stages, Spacecraft Thrusters, Storage of Liquid and Cryogenic propellants and production of liquid hydrogen.	NA	39.70	153.80		Delivery of integrated propulsion system for satellite missions. CE20 Thrust Chamber hot tests in TCT facility, Integration and testing of Cryo Engine. C25 passive stage flight test in LVM3-X flight. Flight test of L110 stage in LVM 3 X flight.  Hardware realisation and delivery of PS2, PS4 stages and control power plants for PSLV. Realisation of GS2 stages, L40 stages and CUS for GSLV Delivery of SITVC and RCS systems for RLV-HEX mission.	Realisation of tested and qualified (a) liquid and cryogenic stages for PSLV and GSLV and (b) Reaction control systems for IRS and GEOSAT Satellites. Liquid and Cryogenic propulsion systems are intermediate products / subsystems used in satellites and launch vehicles.	Technology development, improvement and scaling up is a continuous process to remain state-of-the-art in satellite and launch vehicle technology and to achieve maximum self-reliance in this strategic area.	Liquid Propulsion Systems Centre is the lead centre for development of liquid and cryogenic propulsion systems and has established unique technical infrastructure (test and fabrication facilities) at Mahendragiri, Valiamala and Bangalore.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	(4ii)	4(iii)	5	6	7	8
	<b>LAUNCH VEHICLE TECHNOLOGY</b>									
11	Manned Mission Initiative/Human Space Flight Program	Development of critical technologies for human spaceflight like Crew Module (CM) system, Environmental Control and Life Support System (ECLSS), Flight suit (FS) and Crew Escape System (CES).	145.00 (Pre-project phase)	---	17.50	---	Crew Module readiness for experimental Mission of GSLV-MkIII. Post flight analysis of Crew Module Data. Realization of structures/ subsystems of Pad abort test.	The final outcome, in terms of availability of technologies for manned mission would take about 3-4 years.	Crew Module Atmospheric Re-entry Experiment (CARE) Mission is planned during 2014-15.	
12	Semi-cryogenic Engine / Stage Development	Developing a higher thrust semi-cryogenic core stage for the unified modular launch vehicle.	1798.00	---	150.00		Engine sub-systems realization. Development of advanced materials. Installation of facilities at LMF Development of Engine Systems.	The project is in initial stages. The final outcome, in terms of availability of higher thrust semi-cryogenic stage is expected after six years.	The project was approved in Jan 2009.	Semicryogenic engine is cost effective and eco-friendly technology which is expected to ensure low cost access to space.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15				Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR					
1	2	3	4	4(i)	(4ii)	4(iii)		5	6	7	8
<b>LAUNCH VEHICLE TECHNOLOGY</b>											
13	Indian Institute of Space Science and Technology	To develop high quality manpower required for Space Science, technology and applications programmes.	NA	13.50	109.00	---		Completion of admissions for the academic year 2014-15.	The third batch of students have been inducted to ISRO Centres/ units during August 2013. 4th batch of graduates expected to be inducted during August 2014.	Completion of admissions for new Academic year by July 2014	IIST has started the courses from the Academic year 2007-08. The annual intake of the institute is 156 students for three courses in Avionics, Aerospace engg and applied science. The IIST campus is now located in Valiamala.
14	Trisonic Wind Tunnel Project	To provide test facilities for future launch vehicle developments in Aero-dynamic characterisation in subsonic, transsonic and supersonic mach number.		0.00	10.00			Approval of the project report.	To provide Aero-dynamic test facilities for future launch vehicles.	The project report of Trisonic wind tunnel project is expected to be approved in 2014-15	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15				Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR					
1	2	3	4	4(i)	(4ii)	4(iii)		5	6	7	8
<b>LAUNCH VEHICLE TECHNOLOGY</b>											
15	Oceansat-3	Development and Launch of Oceansat-3 satellite for Oceanographic applications. This will be a continuation mission to Oceansat-1 and Ocean-sat-2.	Yet to be approved	--	25.00	--		Approval of Project Report	Partial Outcome: Processing of Project Report for necessary approval.	The Project Report is expected to be approved during 2014-15	Oceansat-3 will provide continuity of data for already established services in the area of Oceanographic applications.
16	Resourcesat-2A	Develop and Launch Resourcesat-2A satellite to provide continuity of data in the area of Natural Resources Management.	200.00	---	50.00	---		Realisation of various subsystems. Commencement of satellite integration.	Partial Outcome: Commencement of satellite integration is expected during 2014-15.	The integration and testing activities of Resourcesat-2A is expected to be completed in 2015.	Resourcesat-2A is a follow-on mission to Resourcesat-2 satellite which was launched on 2011.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15				Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR					
1	2	3	4	4(i)	(4ii)	4(iii)		5	6	7	8
<b>LAUNCH VEHICLE TECHNOLOGY</b>											
17	Cartosat-3	Develop and Launch an advanced remote sensing satellite with enhanced resolution of 0.25m for cartographic applications and high resolution mapping.	Yet to be approved	---	10.00	---		Approval of Project Report	Partial Outcome: Processing of Project Report for necessary approval.	The Project Report is expected to be approved during 2014-15	
18	Scattsat	Develop and Launch a Remote Sensing Satellite with pencil beam Ku-band scatterometer and millimeter wave sounder.	Yet to be approved	---	10.00	---		Review of Project and its submission for approval.	Partial Outcome: Approval of Project Report for Scattsat	Government approval for Scattsat 2014-15.	Scattsat will provide data for measurement of wind vector and vertical temperature profile of atmosphere useful for atmospheric & Oceanographic studies.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15				Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
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1	2	3	4	4(i)	(4ii)	4(iii)		5	6	7	8
	<b>SATELLITE TECHNOLOGY</b>										
19	RISAT-1A	Develop and Launch a Microwave Remote Sensing Satellite with C-band Synthetic Aperture Radar for Flood Management and Agricultural Applications	Yet to be approved	---	10.00	---		Finalisation of project report for RISAT-1A and processing the same for approval of the Government.	Partial Outcome: Approval of Project Report for RISAT-1A	Government approval for RISAT-1A is expected during 2014-15.	RISAT-1A is a follow-on mission to RISAT-1 with C-band multi-polarised Synthetic Aperture Radar having capability of imaging under all weather conditions.



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1	2	3	4	4(i)	(4ii)	4(iii)	5	6	7	8
	<b>SATELLITE TECHNOLOGY</b>									
20	Cartosat-2E	Develop and launch a high resolution remote sensing satellite with improved resolution of 0.65 meter panchromatic band along with imaging capacity multi-sepectral band for Cartographic application and high resolution mapping	160.00	0.00	25.00		Realisation of Spacecraft structure	Partial Outcome: Delivery of spacecraft structure is expected during 2014-15		
21	RISAT-3	Develop and launch a Radar Imaging Satellite with all weather day and night imaging capability.	(Project not yet approved)	---	1.00	---	Finalisation of project report for RISAT-3 and processing the same for approval of the Government.	Partial Outcome: Approval of Project Report for RISAT-3	Government approval for RISAT-3 is expected during 2014-15.	RISAT-3 is a microwave remote sensing satellite for disaster management and agriculture applications.

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1	2	3	4	4(i)	(4ii)	4(iii)		5	6	7	8
	<b>SATELLITE TECHNOLOGY</b>										
22	GEO-Imaging Satellite (GISAT)	To Develop a geosynchronous satellite capable of imaging in visible and thermal band with 50m resolution for continuous observation of Indian Sub-continent for quick monitoring of disasters, natural calamities and episodic events	392.00	--	63.00	--		Completion of Preliminary Design Review (PDR)	Partial Outcome: Completion of PDR and Payload and other subsystems of GISAT is expected during 2014-15.	GISAT was approved in 2009.	

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	<b>SATELLITE TECHNOLOGY</b>										
23	Indian Regional Navigational Satellite System	To develop a constellation of Indian Regional Navigational Satellite System (IRNSS) for providing positioning services.	1420.00	---	120.00	---		Launch of three IRNSS Satellite i.e. IRNSS - 1B, 1C & 1D.  Establishment of Ground elements.	Partial Outcome: Realisation of three spacecrafts and ground systems.	IRNSS is a constellation of 7 satellites expected to be completed during 2015-16.	Satellite Navigation is strategically an important area of Space technology applications.
24	GSAT-11: Advanced Communication Satellite.	Development and launch of a 4T class communication satellite with advanced communication payloads.	500.00	---	164.50	---		Realisation of spacecraft structure.  Completion of Critical Design Review (CDR).  The review of technical details of ground segment	Partial Outcome: Completion of CDR and technical requirements review of ground segment	Government have approved the project in August 2009.	

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1	2	3	4	4(i)	(4ii)	4(iii)	5	6	7	8
	<b>SATELLITE TECHNOLOGY</b>									
25	ISRO Satellite Centre	Developing Satellite Technology and implementation of satellite systems for scientific, technological and application missions.	NA	106.28	262.88	---	Technology Development initiatives - High Power High Throughput Satellite Platform and 6 Ton class, Spacd Docking experiment. Assembly, integration and testing of Satellites for launch. (IRNSS-R1B, 1C & 1D, GSAT-16)  The structure delivery and fabrication activities for GSAT-16, IRNSS-1E, 1F & 1G and Resourcesat - 2A.	Technology development initiatives and spacecraft hardware development and realisation lead to state-of-art satellites for Indian Space Programme.	Technology development, improvement and scaling up is a continuous process to remain state-of-the-art in satellite technology and to achieve maximum self-reliance in this strategic area.	The ISRO Satellite Centre (ISAC) is the lead centre for Satellite Technology. A new facility, ISRO Satellite Integration and Test Establishment (ISITE) including a Comprehensive Assembly, Test and Thermo-Vacuum Chamber (CATVAC) has been set up recently.

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	<b>SATELLITE TECHNOLOGY</b>									
26	Laboratory for Electro-optics Systems. (LEOS)	Research and Development in the field of electro-optics systems required for satellites.	NA	---	60.13	---	<p>Satellite integration level testing of sensors for GSAT-16, IRNSS-R1B, 1C &amp; 1D, and Resourcesat - 2A.</p> <p>Development of Sensors and Optics for GSAT-11, Cartosat-3, Chandrayaan-2 and Oceansat-3.</p>	<p>Realisation of tested and qualified electro-optical sensors such as earth sensor, sun sensor, star sensor, magnetometer and sensor electronics for satellites.</p> <p>Electro-optic sensors are intermediate products used in satellites.</p>	<p>Technology development, improvement and scaling up is a continuous process to remain state-of-the-art in Electro-optics sensors technology and to achieve maximum self-reliance in this strategic area.</p>	<p>LEOS have developed unique technological capability in the field of optics fabrication and Micro Electro-Mechanical Systems (MEMS) for space applications.</p>

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SATELLITE TECHNOLOGY										
27	Semi-conductors Laboratory (SCL)	Design, development and manufacture of Very Large Scale Integrated (VLSI) circuits and system / board level products and leading R & D effort in the area of microelectronics.	NA	46.43	67.84	---	Process Qualification and Operationalisation of 8" FAB line.  Development of products such as Acoustics sensors, pyro thruster, micro valve, Accelerometer etc.	Realisation of micro electronic devices such as ASICs, MEMS based devices, CCDs, memories, etc, for strategic applications. The output of this unit is an intermediate product used as components / devices in satellites and launch vehicles.	Technology/ process / device development, improvement and scaling up is a continuous process to remain state-of-art in the areas of micro-electronics technology and to achieve maximum self-reliance in this strategic area.	SCL has integrated capability comprising of design, wafer fabrication (up to 0.8 micron technology), testing, packaging, quality assurance and system /board level assembly of micro-electronics devices. It has developed VLSI products, sensing devices and MEMS for strategic organisations such as DRDO, DAE and ISRO.

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	<b>SATELLITE TECHNOLOGY</b>									
28	Satish Dhawan Space Centre - SHAR. (SDSC-SHAR)	To build, maintain and operate state-of-the-art launch infrastructure for assembly and launching of rockets, solid propellant preparation and auxiliary support facilities.	NA	164.18	344.12	---	Preparation of Launch vehicle segments, Integration, propellant servicing, and launch of PSLV flights.  Preparation of L40 strap-ons, GS2 and cryo stages. Launch support to GSLV launches. Production of S200 segments for experimental flight of GSLV MK III.  Realisation of Mechanical structure, Digital receiver system, RF front end system, Data processing system, DC Power distribution system and commencement of integration of sub systems for Multi-Object Tracking Radar.	Realisation of tested and qualified solid motors for PSLV and GSLV.  Solid propellant motors and Launch complex facilities are intermediate stages for launching of rockets.	Launch support for PSLV C23, C24, C26, C27 and C28 & GSLV-Mk III experimental flights are planned to be completed in 2014-15	A State-of-the-art new Mission Control Centre and Launch Control Centre have been established at Sriharikota to enable launch of future advanced launch vehicles as well as to provide redundancy for the existing MCC.

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	<b>LAUNCH SUPPORT, TRACKING NETWORK &amp; RANGE FACILITIES</b>										
29	Realisation Second vehicle Assembly Building	To establish Second Vehicle Assembly Building at Sriharkota. To provide infrastructural support for enhanced launch of PSLV and GSLV.	363.95	0.00	50.00			Configuration finalization, completion of design reviews & initiation of Civil Works and procurement action for fabrication and supply for Second Vehicle Assembly Building.	To support enhanced launch frequency of PSLV & GSLV.	Realisation Second vehicle Assembly Building is approved in 2013.	



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	<b>LAUNCH SUPPORT, TRACKING NETWORK &amp; RANGE FACILITIES</b>									
30	ISRO Telemetry, Tracking and Command Network. (ISTRAC)	To provide mission support (Telemetry, tracking and command) for low earth orbit satellites as well as launch vehicle missions through a network of ground stations.	NA	59.19	97.85	---	On-orbit operation and maintenance of all Indian Remote Sensing satellites. Launch and downrange tracking support for C23, C24, C26, C27 and C28. LEOP support for IRNSS, MARS Orbiter Mission and GSAT-16. Operationalisation of IRNSS Ground Segment.	Enabling operational services of remote sensing and scientific satellites.	On-orbit operation and maintenance of satellites is a continuous round-the-clock process.	ISTRAC is an operational centre responsible for onorbit maintenance and operations of all low earth orbit satellites (like IRS) and planetary missions (like Chandrayaan-1).  ISTRAC has established a Special Deep Space Network at Bylalu near Bangalore for Chandrayaan-1 with a 18 m dia and 32 m dia Antenna realised through Indian Industries.

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	<b>LAUNCH SUPPORT, TRACKING NETWORK &amp; RANGE FACILITIES</b>									
31	Space Applications Centre (SAC)	Design and development of payloads for communication, meteorological and remote sensing satellites and conduct space applications research and development.	NA	144.51	281.52	---	<p>Delivery of payloads for INSAT-3DR and IRNSS-R1D, R1E, R1F &amp; R1G.</p> <p>Development of payloads for Chandrayaan-2, GISAT, Resourcesat-2A.</p> <p>Development of technology for High Resolution Imaging Satellite.</p> <p>Ku &amp; Ka band Antenna Tracking systems.</p> <p>Ka band filters/multiflexers and digital beam forming network.</p>	<p>The payloads are intermediate products required for building satellites.</p> <p>Technology development initiatives and experiments lead to realisation of state-of-the-art payloads.</p>	<p>Technology development, improvement and scaling up is a continuous process to remain state-of-the-art in payload sensors, communication transponders and space applications technology and to achieve maximum self-reliance in this strategic area.</p>	

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1	2	3	4	4(i)	(4ii)	4(iii)		5	6	7	8
	<b>SPACE APPLICATIONS</b>										
32	Development and Educational Communication Unit (DECU)	Conceptualisation, definition, planning, implementation and socio-economic evaluation of the developmental applications of space technology.	NA	9.75	31.05	---		Submission of Feasibility Report on new Model of Tele-education. Content generation for EDUSAT users. Extension of Tele-medicine to new locations. Refurbishment of TM Nodes and making them operational.	The Tele-education, Tele-medicine and VRCs provide satellite connectivity for various development programmes implemented by State / Central agencies and NGOs. The benefit of these programmes is augmentation of the Education and healthcare infrastructure in the country for National development.	The application of space technology for developmental communication and education is a continuous process.	The user ministries concerned for EDUSAT network, Tele-medicine network and VRCs are Ministry of HRD, Ministry of Health and Family Welfare and Rural Development respectively.

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1	2	3	4	4(i)	(4ii)	4(iii)	5	6	7	8
	<b>SPACE APPLICATIONS</b>									
33	National Natural Resources Management System (NNRMS)	Developing National Natural Resources Management Applications using Remote sensing data and supporting region-specific remote sensing applications.	NA	---	30.30	---	Completion of 10 cycle of LULC Mapping & statistics generation (1:250000 scale).  Commencement of 11th cycle LULC mapping (1:250000 scale).  Completion of NRC Geomorphology and Lineament maps (1:50000) maps.  Completion of 2nd cycle LU/LC mapping (1:50000 scale) and hosting on Bhuvan.	Image processing tools / software and updated information on Natural resources for use by the concerned Ministries in Government.	The application of space technology for natural resource management is a continuous process.	<p>NNRMS is a national level apex body in the country guiding and co-ordinating the application of satellite based remote sensing for natural resource management applications in various thematic areas.</p> <p>Imageries of IRS are used by Ministry of Urban Development, Ministry of Agriculture, Ministry of Water Resources, Ministry of Earth Sciences, Ministry of Rural Development, Ministry of Environment and Forests, Ministry of S &amp; T and State development agencies for various natural resource management applications.</p>

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<b>SPACE APPLICATIONS</b>										
34	Earth Observation Application Mission	To evolve newer applications / R&D programmes, guiding remote sensing application programme with the user agencies.	NA	---	4.03	---	Earth Observation application projects - Fire risk alarm system, Narcotic Crop Assessment Project, snow and glacier studies, FASAL software development, application of Hyperspectral remote sensing data, study of water quality parameters, integration farming system analysis, assessment of mountain ecosystem in processes in North-west Himalayas		Application of Earth Observation data for developmental activities is a continuous process.	

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	<b>SPACE APPLICATIONS</b>										
35	North Eastern Space Applications Centre (NE-SAC)	To promote application of space technology for the development of north-eastern region in the areas of natural resource management, developmental planning, disaster management support, interactive training, tele-education, tele-medicine and other space applications.	NA	2.90	18.90	---		North Eastern District Resources Plan to expand to 25 districts. Operationalisation of North East Regional node for Disaster Risk Reduction. Estimation of regional radiative forces, cyclone tracking and intensity monitoring for North-Eastern region.	Space technology inputs related to natural resource management, developmental communications and disaster management support for developmental programmes of the NE States.	The application of space technology for development of North Eastern Region is a continuous process.	NESAC is setup as an autonomous society jointly with the North Eastern Council to provide space technology based solutions for NE region.

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	<b>SPACE APPLICATIONS</b>									
36	National Remote Sensing Centre (NRSC)	Acquisition, processing, distribution of data from Indian Remote Sensing Satellites and research, development and executing remote sensing application projects in collaboration with users.	NA	103.28	140.81	---	NRSC shall continue to support all services and development works for various natural disasters. Generation of Geophysical parameters and hosting in NICES portal. Land use land cover gridded database for 8th and 9th cycles. Groundwater prospecting (Phase IV): mapping and dissemination for 12 states and 5 UTs. Number of user agencies to whom data dissemination done.	Availability of processed IRS satellite data and value added products of remote sensing technology / methods for use by various Ministries in Government, private entrepreneurs and NGOs.	Reception, processing and distribution of IRS data is a continuing activity.	IRS data are used by Ministry of Urban Development, Ministry of Agriculture, Ministry of Water Resources, Ministry of Earth Sciences, Ministry of Rural Development, Ministry of Environment and Forests, Ministry of Science and Technology and State development agencies for various natural resource management applications.



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	<b>SPACE APPLICATIONS</b>										
37	Indian Institute of Remote Sensing (IIRS)	To develop trained professional in the field of Remote Sensing, Geoinformatics and GPS Technology for Natural Resources, Environmental and Disaster Management.	NA	6.64	33.91	--		Conduct various courses for the Academic year 2014.  Focused research activities in "Monitoring & Assessment of Ecosystem Processes" in North-West Himalayas.  Theme specific customised short term courses for user departments in recent technological and applications such as microwave and hyperspectral remote sensing, advanced GIS techniques and modeling.	Capacity Building in the Area of Remote Sensing, Geoinformatics and GPS Technologies.	Completion of Courses as per Academic Calendar 2013	Since April 30, 2011, IIRS has been functioning as a Unit of ISRO.

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	<b>SPACE APPLICATIONS</b>										
38	Disaster Management Support	Providing space technology inputs and services on a reliable and timely manner for the disaster management system in the country.	NA	---	21.37	---		Response to Major Food Disasters. Emergency communication support towards major disasters. In season daily Forest the monitoring during pre-monsoon (1st Feb to 30 June) Establishment of GCP Library Phase - III.	Strengthening of Disaster Management System in the country.		The Virtual Private Network connects Ministry of Home Affairs with State Emergency Operations Centre for real time exchange of critical information and digital data for Disaster Management.
	<b>SPACE SCIENCES</b>										
39	ASTROSAT	Design and development of a satellite for Multi-wave-length studies of a variety of celestial sources and phenomena using X-ray / Gamma ray astronomy instruments and UV telescope.	177.85	---	4.50	---		Delivery of payloads. Completion of satellite integration.	The project is currently in intermediate stage. Final outcome, in terms of scientific results of the data from the satellite will start accruing after the launch of ASTROSAT satellite.	ASTROSAT satellite launch is planned for 2014-15 onboard PSLV.	ASTROSAT is a unique observatory satellite simultaneously covering a range of high energy radiation hitherto not covered from any other global observatory missions.

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	<b>SPACE APPLICATIONS</b>										
40	Indian Lunar Mission Chandrayaan-1 & 2	The baseline mission objective of Chandrayaan -2 is to soft land at a suitable site on the lunar surface and to carry out in-situ chemical analysis.	811.00	---	60.00	---		Chandrayaan-2: Preliminary Design Review. Realisation of Orbiter Craft primary structure	Final outcome is the enhanced understanding of the Moon and its environment from the analysis of the scientific data received from Chandrayaan satellite.	Chandrayaan -2 project was approved in 2008 with a total cost of Rs. 425 Crores.	Chandrayaan-1 was successfully launched into earth orbit on October 22, 2008. Subsequently, it was placed in the intended lunar orbit and the Moon Impact Probe was released on to the surface of Moon on November 14, 2008. The scientific instruments onboard Chandrayaan -1 satisfactorily provided a new insight on the Moon's origin and evolution.
41	ADITYA-1	To launch a spacecraft, which will be the first Indian Space based solar corona-graph, which will be available for solar coronal observation to all the Indian researchers in the field of Solar Astronomy.	127.75	--	27.00	--		Approval of revised scope of ADITYA-1. Configuration finalisation.	Final outcome is to achieve a fundamental understanding of the physical processes that heat the solar corona, accelerate the solar wind and produce Coronal Mass Ejections (CMEs)	The project is approved in 2009-10 with a total cost of Rs 127.75 Crores.	

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	<b>SPACE SCIENCES</b>									
42	Mars Orbiter Mission	Design, Develop and Launch a Spacecraft to reach and orbit around Mars to study Martian surface features and atmosphere..	450.00	--	71.00	--	Mars Capture. Payload operations.	Final outcome of Mars Orbiter is Mars orbit insertion and payload operations.	Mars Orbiter is scheduled to be inserted in Mars orbit on September 24, 2014	Mars Orbiter Mission is India's first mission to Mars Planet undertaken by ISRO.

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	<b>SPACE SCIENCES</b>									
43	Physical Research Laboratory (PRL)	Carry out basic research in the areas of astronomy and astrophysics, solar physics, planetary science, interplane-tary science, earth's mag-netosphere, ionosphere, atmosphere, earth's surface and interior, theoretical physics, quantum optics / lasers C99	NA	38.00	118.80	---	<p>Payload data analysis from Mars Orbiter.</p> <p>Development of payloads for Chandrayaan-2 mission.</p> <p>Design and development of sub-systems for the proposed X-ray polarimeter mission.</p>	<p>Partial Outcome: Capability to develop complex payloads and analysis of data for space science and planetary exploration.</p> <p>PRL is primarily an R &amp; D institution and the outcome is in the form of expanding our knowledge in the areas of Astronomy and Astrophysics, Solar physics, Planetary science, Earth Science, Atmospheric science and related fields.</p>	<p>Space Science Research is a continuous process.</p>	

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	<b>SPACE SCIENCES</b>										
44	Sensor Payload development / Planetary Science Programme	Design and Development of Engineering model of sensors / scientific instruments for space and planetary science programme.	NA	---	2.60	---		Development of prototype for payloads to be flown in x-ray polarimetric mission.  Development of engineering model for payloads required for atomospheric studies.			

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	<b>SPACE SCIENCES</b>									
45	National Atmospheric Research Laboratory (NARL)	Carryout scientific research in Atmospheric Science and serve as a major national experimental facility for atmospheric research in the country including boundary layer, troposphere, middle atmosphere, thermosphere and ionosphere.	NA	4.70	18.26	---	Development of subsystems for active Phased Array MST Radar.  Installation, Testing and Commissioning of X-Band Polarimetric Radar.  Installation and Commissioning of Brewer MKIII spectrophotometer for continuous monitoring of ozone layer.  Upgradation of climate observatory at Gadanki with inclusion of Methan monitor and organic/black carbon analyzer.	NARL is basically a research institute and the outcome of the programme will lead to expanding our understanding of the complex processes of the lower and middle atmosphere.	The Research is a continuous process.	NARL, located at Gadanki, near Tirupati, has established a major state-of-the-art experimental National MST Radar Facility for middle atmospheric research.



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1	2	3	4	4(i)	(4ii)	4(iii)		5	6	7	8
	<b>SPACE SCIENCES</b>										
46	Atmospheric Science Programme	Undertake studies and research on development of advanced observational tools, use of satellite data and techniques of modeling in atmospheric science leading to user products for adoption by operational agencies.	NA	---	23.37	---		Establishment of instrumentation over oceans. Collaborative programme on Cloud-Precipitation systems. Installation of nearly 37 nos of AWS in various locations including Andaman & Nicobar, Lashadweep and Sundarbans.	The Outcome is Intermediate in nature. The development efforts in terms of observational tools and modeling is applied by the operational agencies towards improved capabilities for weather prediction and climate monitoring.	The Research and development in atmospheric science is a continuous process.	An indigenous low cost version of the Automatic Weather Station (AWS) has been successfully realised towards building a network of AWS in the country, which will substantially enhance the data inputs for weather modeling.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15				Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR					
1	2	3	4	4(i)	(4ii)	4(iii)		5	6	7	8
	<b>SPACE SCIENCES</b>										
47	RESPOND	To strengthen the academia interaction through collaborative research, educational and scientific activities.	NA	---	21.72	---		Supporting Research and Development projects at academic institutions, universities and Space technology cells at IITs / IISc in the area of Space science, technology and applications.	Development of knowledge-base and human resources in academic institutions in the area of space research.	The Research is a continuous process.	Over 80 Universities / institutions from different parts of the country participate in the RESPOND programme. Every year, about 150 R & D projects are undertaken under this programme.
48	ISRO Geosphere Biosphere Programme (ISRO GBP)	To investigate the processes between Geosphere-Biosphere Atmosphere and their interactions, radiative forcing, regional climate, micro gravity and space science promotion / research.	NA	---	20.00	---		Implementation of regional Carbon Tracker for India. Analysis and validation of results in identifying the source and sink areas in cauvery basin. Establishment of Micro Meteorological Tower at ARIES, Nainital for boundary layer flux measurement.	Enhancing the understanding of the dynamics of global environment & its impact on regional climate. Improved weather prediction over Sriharikota which is of paramount importance for rocket launches.	The Research and Development is a continuous process.	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	(4ii)	4(iii)	5	6	7	8
	<b>SPACE SCIENCES</b>									
49	Small Satellites for Atmospheric Studies and Astronomy	To design and develop small satellites for study of Earth's near space environment, study of aerosol and gases, inner magnetosphere and Solar Physics	9.85	---	2.60	---	Realisation of subsystems and payload of the spacecraft.	Partial Outcome: Realisation of subsystems of the spacecraft.	Spacecraft realisation in 2014	Nano satellite for Aerosol monitoring.
50	Other Schemes		NA		5.75	---				
	<b>DIRECTION, ADMINISTRATION AND OTHER PROGRAMMES.</b>									
51	Development of Space Materials and Components	Indigenous development of high reliability electronic components including micro-electronics devices, space grade materials	NA	---	24.55	---	Development of Traveling Wave Tubes, clock oscillator, connectors, Application Specific Integrated Circuits (ASICs), Field Programmable Gate Arrays (FPGAs), sensor devices, polymers, chemicals and metallic materials.	Import substitution of critical space grade materials and components	The indigenous development of space materials and components to maximise self reliance is a continuous process.	More than 150 types of high reliability electronic components and space grade materials, developed and qualified under this programme, are being currently used in various satellite and launch vehicles of ISRO.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15				Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR					
1	2	3	4	4(i)	(4ii)	4(iii)		5	6	7	8
	<b>DIRECTION, ADMINISTRATION AND OTHER PROGRAMMES.</b>										
52	Advance Ordering	Stockpiling of critical components, materials and sub-assemblies for satellites and launch vehicles	NA	---	25.00	---		Procurement of long lead components, sub-materials, sub-assemblies.	Partial Outcome: Procurement planning of components and materials	Continuous process	
53	Others (includes mainly ISRO Head quarters, Civil Engineering Division Head quarters, DOS secretariat and Central Management Expenses)	To provide overall direction and co-ordination of space programmes in the areas of Satellite Com-munications, earth observa-tions, launch vehicle development, space sciences, space industry development, international co-operation and human resource development.	NA	99.00	54.35	---		Corporate functions. Imparting training to international students at UN Centre for Space Science and Technology Education for Asia and the Pacific.	Providing overall direction and co-ordination of the space programme including long term planning.	Continuous process	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	(4ii)	4(iii)	5	6	7	8
<b>DIRECTION, ADMINISTRATION AND OTHER PROGRAMMES.</b>										
54	Master Control Facility	To carry out continuous Monitoring & Control of Geo-Stationary Satellites of India - during initial orbit raising and regular On-orbit phases of various Satellite Missions	NA	35.23	48.84	---	On orbit operations and maintenance of INSATs, GSATs and METSATs.  Launch and Early Orbit Phase (LEOP) Operations of GSAT -16 & 6, IRNSS – 1B, 1C & 1D.  Establishment of Satellite Control Centre for IRNSS Missions.  Establishment of a 11m Full Motion Antenna Terminal with High Tracking Rates	Providing operational services of Geostationary satellites for the users in the area of telecommunications, broadcasting and meteorological data.	On orbit operation and maintenance of satellites is a continuous round-the-clock process.	MCF has set up an Earth Station in Bhopal, Madhya Pradesh to augment the tracking, telemetry and communication infrastructure for GSO satellites.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	(4ii)	4(iii)	5	6	7	8
	<b>INSAT OPERATIONAL</b>									
55	INSAT-3 satellites (including launch services)	Development and launch of third generation INSAT-3 satellites (INSAT-3A to 3E) to augment the capacity of INSAT system.	2979.63	---	10.00	---	Realisation of INSAT-3DR Spacecraft Structure.  Completion of Critical Design Review for INSAT-3DR.	Final outcome: launch and operationalisation of INSAT-3DR satellite.	Completion of Design review of INSAT - 3DR is targeted during 2014-15	INSAT-3A, 3B, 3C, 3D & 3E satellites in INSAT-3, series have already been launched successfully and are being used operationally.  Currently, INSAT-3A, INSAT-3D and Kalpana (METSAT-1) are providing the meteorological data to the users for weather forecasting.
56	INSAT-4 Satellites (including launch services)	Development and launch of fourth generation INSAT-4 satellites to augment the INSAT system capacity.	3642.70	---	37.90	---	Assembly, Integration and Testing of GSAT-6 & GSAT - 16 satellites and its readiness for launch.  Payload and mainframe subsystem realisation of GSAT-9, GSAT-15 satellites.	Launch of GSAT-16 to augment the 48 transponders to INSAT capacity.	GSAT-16 satellite is targeted for launch in 2014-15.	INSAT system currently has 188 Transponders, which is used for Telecommunications, Broadcasting, Business Communications, Rural Area communications, emergency communication and developmental communications.

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	(4ii)	4(iii)	5	6	7	8
	<b>INSAT OPERATIONAL</b>									
57	Service Charges for Leasing of INSAT/GSAT Transponders	To facilitate augmentation of transponder capacity of INSAT/GSAT system.	NA	--	75.24	--	Contract Management service for INSAT Capacity utilisation.			Service Charges to be paid to Antrix Corporation for Managing leasing of INSAT/GSAT transponders.
58	INSAT-3D Launch Services	To Launch INSAT-3D Satellite by using procured launch services.	477.00	--	1.15	--		Full outcome: Launch of INSAT-3D satellite using procured launch Services.	INSAT-3D launched successfully on 26th July, 2013	
59	GSAT-7 Launch Services	To Launch GSAT-7 Satellite by using procured launch services.	479.00	--	1.05	--		Full outcome: Launch of GSAT-7 satellite using procured launch Services.	GSAT-7 launched successfully on 30th August, 2013.	
60	GSAT-15 Satellite	To develop a communication satellite with 24 Ku-band transponders and a GAGAN payload	291.50	---	110.00	---	Realization of subsystems of the spacecraft. Delivery of Payload.	Partial Outcome: Readiness of Payloads and flight subsystems.	Launch of GSAT-15 satellite is planned during 2015.	GSAT-15 will further augment GSAT/INSAT system with 24 Ku-band transponders.



Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15				Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR					
1	2	3	4	4(i)	(4ii)	4(iii)		5	6	7	8
<b>INSAT OPERATIONAL</b>											
61	GSAT-15 Satellite - Launch Services	To secure Launch Slot for GSAT-15 satellite through procured launch services	568.00	---	378.00	---		2nd and 3rd Milestone Payments of the contract.	To secure a launch slot for launching GSAT-15	Launch of GSAT-15 satellite is planned during 2015.	
62	GSAT-16 Satellite	To develop a communication satellite with 24 C-band, 12 Upper Ext-C band and 12 Ku-band transponders.	297.50	---	110.00	---		Completion of Spacecraft level, Assembly, Integration and Testing. Completion of Environmental Test. Readines for Shipment.	Partial Outcome: Readiness of satellite for launch.	Launch of GSAT-16 satellite is planned during 2014-15.	GSAT-16 will further augment GSAT/ INSAT system with 24 C-band, 12 Upper Ext-C band and 12 Ku-band transponders.
63	GSAT-16 Satellite - Launch Services	To secure Launch Slot for GSAT-16 satellite through procured launch services	568.00	---	433.00	---		2nd and 3rd Milestone Payments of the contract.	To secure a launch slot for launching GSAT-16	Launch of GSAT-16 satellite is planned during 2014-15.	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15			Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR				
1	2	3	4	4(i)	(4ii)	4(iii)	5	6	7	8
<b>INSAT OPERATIONAL</b>										
64	GSAT-17 Satellite and follow-on missions	To develop a communication satellite with 24 C-band, 12 Upper Ext-C band and 12 Lower Ext-C band, 4 MSS & 1 DRT transponders.	Yet to be approved	---	50.00	---	Approval of Project Report for GSAT-17 Satellite.	Partial Outcome: Approval of GSAT-17 project report.	Approval of GSAT-17 satellite is expected during 2014-15	
65	GSAT-17 Satellite - Launch Services	To secure Launch Slots for Future Communication satellites through procured launch services	Yet to be approved	---	10.00	---	RFP for Launch services Contract	To secure a launch slot for launching GSAT-17 satellite	Signing of Launch Services Contract is targetted during 2015-16	
66	GSAT-18 Satellite	To develop a communication satellite with 24 C-band, 12 Upper Ext-C band and 12 Ku-band transponders and 1 Ku-band beacon transmitter	Yet to be approved	---	50.00	---	Approval of Project Report for GSAT-18 Satellite.	Partial Outcome: Approval of GSAT-18 project report.	Approval of GSAT-18 satellite is expected during 2014-15.	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15				Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR					
1	2	3	4	4(i)	(4ii)	4(iii)		5	6	7	8
<b>INSAT OPERATIONAL</b>											
67	GSAT-18 Satellite - Launch Services	To secure Launch Slots for Future Communication satellites through procured launch services	Yet to be approved	---	10.00	---		RFP for Launch services Contract	To secure a launch slot for launching GSAT-18 satellite	Signing of Launch Services Contract is targetted during 2015-16.	
68	GSAT-19 Satellite	To develop a communication satellite with 3 Ka band, 2 normal C-band, 2 MSS transponders	Yet to be approved	---	10.00	---		Approval of Project Report for GSAT-19 Satellite.	Partial Outcome: Approval of GSAT-19 project report.	Approval of GSAT-19 satellite is expected during 2014-15.	
69	GSAT follow-on Satellite and missions - Launch Services	To develop follow-on communications satellites in order to augment INSAT/GSAT transponder capacity	Yet to be approved	---	20.00	---		Preparation of project reports for GSAT - 11S.	Preparation of Project report.	Report is expected to be ready in 2014-15.	

Sl. No.	Name of the Scheme / Program	Objective / Outcome	Total Sanctioned Cost (In respect of Projects)	Outlay 2014-15				Quantifiable Deliverables	Projected Outcome	Processes / Timelines	Remarks
				Non-Plan	Plan	CEBR					
1	2	3	4	4(i)	(4ii)	4(iii)		5	6	7	8
	<b>INSAT OPERATIONAL</b>										
70	Augmentation of Capacity through leasing of transponders from foreign Satellite	Procurement/ hiring of transponder capacity from foreign agency in order to augment INSAT/GSAT Transponder capacity	N.A.	---	47.80	---		RFP preparation for hiring of transponders.	Completion of RFP		
71	Procurement of Heavier class satellites.	Procurement of heavier class of communication satellite to augment INSAT/GASAT capacity	Yet to be approved	---	10.00	---		Evaluation of offers.	Augmentation of INSAT capacity.		
	<b>Total</b>		<b>24157.56</b>	<b>1238.00</b>	<b>6000.00</b>						

## **REFORM MEASURES AND POLICY INITIATIVES**

India has an impressive array of achievements in the area of development of satellites, launch vehicles, associated ground segment and most of relevant societal applications. Some of the recent applications of space technology such as Tele-medicine and Tele-education have had a far reaching impact on national development. These efforts together with conducive policies and reform measures adopted by the Department have yielded rich results.

### **2. Space Industry Partnership**

2.1 The Department of Space has nurtured a strong partnership with Indian Industries in realizing the objectives of the Space Programme. More than 500 small, medium and large scale Industries participate in the programme in the form of hardware development and supply, software and other services. Almost 60% of a launch vehicle cost flows to Indian Industries. In the recently developed applications, almost 100% of the ground segment equipments/ services for Tele-education and Tele-medicine have been farmed out to Indian Industries. The Industry participation policy of the Department has adopted several aggressive measures to promote the participation of Industries in the Space Programme. The Department, so far, has developed and transferred about 300 technologies to Industries for commercialization. It is important to note that this partnership with Industries has enabled the Department to meet the growing challenges of advanced technology, handling complex manufacturing jobs and increasing demand for space services without any significant increase in in-house manpower.

### **3. Improved Delivery Mechanisms**

3.1 To demonstrate the potential of satellite technology for development of rural areas, the Department has set up the Village Resource Centres (VRCs) on a pilot scale in association with selected NGO's, Trusts and State Government Departments.

3.2 VRCs provide a variety of space based products and services, such as: Tele-education; Tele-medicine; information on natural resources; interactive advisories on agriculture, fisheries, land and water resources management, livestock management, interactive vocational training towards alternate livelihood etc. DOS/ISRO primarily provides communication bandwidth, Tele-medicine and Tele-education facilities and available/customized spatial information on natural resources along with indigenously developed query system. The responsibilities of housing, managing and operating VRCs, with all relevant contents rest with the associating agencies.

3.3 So far more than 456 VRCs have been set up in Andhra Pradesh, Assam, Bihar, Delhi, Gujarat, Himachal Pradesh, Jharkhand, Karnataka, Kerala, Maharashtra, Madhya Pradesh, Meghalaya, Nagaland, Orissa, Rajasthan, Sikkim, Tamil Nadu/Pudhucherry, Uttar Pradesh, Uttarakhand, West Bengal, A&N Islands. Around 45 NGOs/Trusts/Institutes/Govt. Departments have associated with DOS/ISRO in VRC programme.

3.4 VRCs have provided various space technology enabled services such as tele-healthcare, tele-education, natural resources information etc. The major benefits of the VRC programme include advisories related to agriculture like crop pest and diseases, fertilizer/pesticides, organic farming, crop insurance etc., live stock, poultry, career guidance to rural students, skill development and vocational training etc. to the rural population.

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## REVIEW OF PERFORMANCE OF THE MAJOR ONGOING PROJECTS/PROGRAMMES/CENTRES OF DOS/ISRO

### ONGOING PROJECTS/PROGRAMMES

#### 1. GSLV-Operational Project

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
3550.96	2174.34	214.91	180.00	202.67

1.1 In order to meet the launch requirement of 2 tonne class of operational INSAT/GSAT satellites, the GSLV-Operational Project has been conceived. Currently, the approved scope of the Project include realization of 16 launch vehicles (F01-F16).

1.2 The first operational flight GSLV-F01 was successfully launched on September 20, 2004 with GSAT-3 (Edusat) onboard. The second operational flight GSLV-F02 launched on July 10, 2006 with INSAT-4C on board was unsuccessful due to malfunctioning of one of the strap-on stages. However, GSLV-F04 carrying INSAT-4CR was successfully launched on September 2, 2007. The GSLV F-06 mission carrying GSAT-5P launched on December 25, 2010 was unsuccessful due to untimely and inadvertent snapping of a group of 10 connectors located at the bottom portion of the Russian Cryogenic Stage.

1.3 Considering the successive failures of GSLV D3 and GSLV F06 mission, it has been decided to establish the robustness of GSLV vehicle by having the next two missions i.e. GSLV D5 and GSLV D6 as developmental flights with indigenous cryo stages.

1.4 C25 thrust chamber test facility (TCT) at LMF was augmented for high altitude test (HAT) of CUS engine. Commissioning trials of HAT facility were carried out followed by Cold start test and two Hot Tests which were successful.

1.5 Acoustic test of lower shroud was carried out at NAL incorporating new elements like proximity sensors, video imaging system and modified lanyard mounting system and performance of all the new elements was normal. Integrated separation test of lower shroud was carried out successfully. Deflection tests of six polyimide pipelines of varying profiles were successfully carried out under LN2 condition with internal pressure of 4 bar.

1.6 The entire aerodynamic characterization of GSLV has been revisited. In total, more than 900 blow-downs have been carried out in the wind tunnels of NAL, Bangalore & GK, Russia to characterize the vehicle in terms of aerodynamic forces and moments, steady pressure loads, unsteady aerodynamic loads and aero-elastic contributions. Vehicle structural and control system design margins were established with revised aerodynamic data.

1.7 CUS-05 flight stage was realized at LPSC Mahendragiri. Flight preparation of cryo stage was carried out at Technical complex, SDSC-SHAR. Banting and Singapore ground stations were included for GSLV D5 mission to ensure continuous visibility during the CUS regime.

1.8 GSLV-D5 launch campaign commenced on 31 January 2013 with launch planned on 19 August 2013. On the launch day (19 Aug 2013), fumes were noticed in 1/2V area and UH-25 propellant dripping over 1/2V and GS1 dome and thereafter launch was called off at T-1:30:00 Hrs.

1.9 A High Level Task Team was constituted to give recommendations to restore GSLV D5 vehicle to flight configuration. The recommendations of High Level task team are firmed-up. The project has taken action to realize all the additional stages as per the recommendations of High level task team. All the additional stages were realized. Launch campaign re-commenced on 18<sup>th</sup> October 2013. The launch of GSLV-D5 with indigenous cryo stage was successfully carried out on 5<sup>th</sup> January, 2014.

1.10 CUS06 stage integration activities are in progress for GSLV D6 mission. All the liquid stages and S139 stage realized for GSLV D6 launch were diverted for GSLV D5 mission.

## 2. GSLV Mk-III Development

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
2498.00	2376.54	139.53	80.13	180.10

2.1 GSLV Mk-III Project is responsible to develop a cost effective heavy lift Launch Vehicle (LVM3) capable of launching 4 ton class of communication satellites into Geo-synchronous Transfer Orbit (GTO). The major propulsion modules in LVM3 include two S200 solid strap-on stages, L110 core liquid stage and C25 cryogenic upper stage. Both S200 and L110 stages have been qualified through static hot tests. S200 flight motors are ready and Flight Readiness Review (FRR) completed. L110 flight stage is in the final stage of assembly. All facilities at Launch Complex are ready for the first flight of LVM3. First hot test of C25 thrust chamber was successfully carried out at TCT facility, Mahendragiri.

2.2 Ground Resonance Test of GSLV Mk-III in full vehicle configuration has been carried out. All environmental qualification tests of sub assemblies have been completed. Structural qualification test of 5 m diameter Heat shield has been completed. Test rigs are under erection for two pending structural qualification tests. Functional qualification tests of S200, L110 and Space craft separation systems and pyros are completed. Preparations towards the functional separation test of heat shield are also progressing well. C25 integrated engine test is planned during 2014-2015.

2.3 The first experimental sub-orbital flight test (LVM3-X) with passive C25 stage is during 2014. Trajectory design has been completed and flight simulation activities are progressing.



### 3. Polar Satellite Launch Vehicle - Continuation (PSLV-C) Project

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
2863.52	2353.24	350.00	162.68	390.00

3.1 The Polar Satellite Launch vehicle (PSLV) is designed and developed during 1982 - 1993 period to cater to the needs of launching satellites in Sun Synchronous and Low Earth Orbits. PSLV is configured as a four stage vehicle with alternate solid and liquid propulsion stages. The booster stage along with the Strap-on motors and the third stage are solid motors while the second and fourth stages use liquid engines. The overall length of PSLV is 44.4m and the lift off mass is 320t with core vehicle diameter of 2.8m. The Payload Fairing is of 3.2m diameter. The 1st stage consists of S139 solid motor with 139t propellant and six strap-on motors (S12) each carrying 12.2t propellant. The 2<sup>nd</sup> stage (PL40) carries 42t Earth storable liquid propellant. The 3rd stage is a composite case Solid motor containing 7.6t propellant. The 4th stage (L2.5) is a twin engine pressure fed liquid stage with 2.5t propellant.

3.2 PSLV has a capability to launch 1750 kg class satellites into 600km Sun Synchronous Polar Orbit (SSPO) and 1425 kg satellites into a Sub-GTO of 284 km x 21000 km. PSLV has the versatility to launch multiple satellites and also has the capability to inject satellites into various orbits. Currently two versions of PSLV are operational, namely the PSLV Core-Alone (without Strap-on motors) and PSLV-XL (with six extended version of Strap-on motors).

3.3 Major accomplishments during 2013-14 were the launch of PSLV-C22/IRNSS 1A mission on 1<sup>st</sup> July 2013, PSLV-C25/Mars Orbiter Mission on 5<sup>th</sup> November 2013 and PSLV C24 carrying the 2<sup>nd</sup> navigational satellite IRNSS-1B on 4<sup>th</sup> April, 2014. In the current year it is planned to launch PSLV-C23, a dedicated commercial launch carrying SPOT-7 spacecraft from Astrium, France along with 3 Nos. of passenger payloads planned from the Second Launch Pad and IRNSS-1C onboard PSLV-C26.

### 4. Cryogenic Upper Stage (CUS) Project

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
335.89	335.88	0.10	0.10	0.10

4.1 The objective of the Project is to develop and qualify an indigenous restartable cryogenic stage employing liquid oxygen as oxidizer and liquid hydrogen as fuel for the upper stage of GSLV.

4.2 The CUS-3 Stage was flight tested in GSLV-D3 mission on 15<sup>th</sup> April, 2010 which was unsuccessful. A comprehensive technical assessment of CUS-3 flight stage by National Panel of Eminent Experts was carried out and recommendations were implemented. Accordingly, the margins on fuel booster turbo pump

speed were demonstrated in ground test. Ground preparation of the stage was satisfactory and achieved the required lift off conditions. On board chilling of feed lines, maintenance of the propellant tank pressures during flight etc., were also successfully demonstrated and required conditions for the engine ignition were achieved.

4.3 The expected performance of the stage was not achieved due to the anomaly in the Fuel Booster Turbo-Pump (FBTP). Subsequently, Fuel Booster Turbo Pump (FBTP) failure simulation tests were conducted at SET facility considering various suspected failure scenarios in GSLV D3 mission. Later, based on FAC & Expert Committee recommendations, FBTP was modified with increased seal clearances & qualification tests were carried out. Also, engine level tests were also conducted using A4 Main Engine, wherein modified OBTP was flight acceptance tested & performance of modified FBTP was assessed.

4.4 CUS 05 Flight Stage was flagged off to SDSC-SHAR for GSLV D5 Mission on 13th May, 2013. CUS 05 stage servicing operations were carried out as part of GSLV D5 launch count down. Second HAT test of CUS A4 engine with sequence shift (100 ms advancement of Main Engine LOX injection valve) was successfully conducted & demonstrated the engine build up with the modified start sequence. Completed CUS Modified Fuel Booster Turbo Pump (FBTP) Repeat Qualification Tests (8 tests with 16 starts/stops for a cumulative duration of 1452 s which includes an up-rating duration of 860 s). With this, endurance test on single hardware (through multiple tests in standalone mode) for double the flight duration is completed. Stage systems viz. propellant tanks & structures, level sensor, propellant acquisition system etc realized for CUS06 Flight Stage realization for GSLV D6 mission. Flight assembly of Oxidizer & Fuel Booster Unit completed. System level assembly/test activities are in progress for engine systems.

4.5 Integration and delivery of CUS 06 and CUS 07 flight stages for GSLV mission is planned during 2014-15.

## 5. Indian Remote Sensing Satellites (IRS) Projects

(₹ in crores)

	<b>Sanctioned Cost</b>	<b>Expenditure to end of March 2013</b>	<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
Oceansat-2&3	129.15	126.18	0.00	0.00	0.00
Resourcesat-2&3	138.79	137.83	0.00	0.00	0.00
Resourcesat-2A	200.00	4.45	28.00	15.00	50.00

5.1 Oceansat-2 envisaged as in-orbit replacement to Oceansat-1 carries Ocean Color Monitor and a Ku-band pencil beam Scatterometer. In addition, it carries a Radio Occultation Sounder for Atmospheric Studies (ROSA), developed by the Italian Space Agency (ASI). Oceansat-2 is used for identification of Potential Fishing Zones, sea-state forecasting, coastal zone studies and provide inputs for weather forecasting and climatic studies. The spacecraft was launched successfully onboard PSLV-C14 on 23<sup>rd</sup> September 2009. The payloads have been commissioned and the performance of the spacecraft is normal.

5.2 Taking into account the increased use of space imageries for different applications and continued Earth Observation services required from the IRS satellites, Resourcesat-2 was conceived as a continuity mission with enhanced capabilities, which will be mainly for crop applications, vegetation dynamics and natural resources census applications. Resourcesat-2 was successfully launched onboard PSLV C-16 on April 20, 2011.

5.3 Resourcesat-2A has been approved with an estimated cost of ₹ 200.00 Cr. Resourcesat-2A is conceived as a follow-on mission to Resourcesat-2 intended to provide continuity of services with enhanced capabilities, which will be mainly for crop applications, vegetation dynamics and natural resources census applications. The configuration is similar to Resourcesat-2. The spacecraft mass is around 1206 kg with a power generation capacity of 1250W and mission life of 5 years. Structure delivered to clean room and RCS integration activities are in progress. Mainframe sub systems realization is in progress. Development of payload systems is in advanced stage.

## 6. Radar Imaging Satellite Project (RISAT)

(₹ in crores)

	<b>Sanctioned Cost</b>	<b>Expenditure to end of March 2013</b>	<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
RISAT-1	378.49	377.88	0.00	0.00	0.00
RISAT-1A	Yet to be approved	0.00	1.00	0.00	1.00

6.1 Radar Imaging Satellite (RISAT) is a microwave remote sensing mission with Synthetic Aperture Radar (SAR) as a payload operating in C band. The Satellite is designed for an operational life of 5 years. The total mass of the satellite works out to the 1780 kg. The Satellite was successfully launched by PSLV-C19 on 26<sup>th</sup> April, 2012.

6.2 RISAT-1A is conceived as a follow-on mission to RISAT-1 satellite. RISAT-1A will have a Synthetic Aperture Radar operating in C-band capable of imaging in day-night all-weather conditions.

## 7. Indian Lunar Mission – Chandrayaan-2

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
425.00	161.37	78.00	24.00	60.00

7.1 The baseline mission objective of Chandrayaan-2 is to soft land at a suitable site on the lunar surface and carry out in-situ chemical analysis. Chandrayaan-2 is envisaged as a two module configuration comprising of Orbiter Craft module and Lander Craft module. Both the modules interfaces mechanically by a inter module adapter. Chandrayaan-2 is planned to be launched onboard GSLV MK II with a lift off mass of 2560 kgs and will carry two rovers each weighing 50 kgs. One Rover is developed by Russian Space Agency and the other at ISRO Satellite Centre.

7.2 Preliminary studies for the landing site selection have been done and a possible list of payloads has been prepared. Design & configuration finalization is in progress. An integrated review of Chandrayaan-2, to assess the programmatic re-alignment, has been conducted. The review recommended that India could realize the Lander module in a time frame of next few years. Consequent to the review, Advisory Committee on Space Science (ADCOS) has finalized the payloads to be accommodated on the Lander module. Mission configuration details are near finalization. Another review has been conducted to finalize the specification of the payloads for Lander and Rover modules.

7.3 Spacecraft reconfigured in view of indigenous Lander and delta PDR of revised configuration is planned. Detailed design of structural elements of orbiter and lander is in progress. Six wheel rover configuration assemblies completed and fabrication is in progress. Tests on development model of rover are in progress.

## 8. Astrosat 1&2

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
177.85	169.16	5.00	2.25	4.50

8.1 The Astrosat project is aimed at design, development, fabrication and launch of an astronomical observatory for study of cosmic sources. Astrosat has been configured to carry onboard five payloads, to meet the mission goals. The spacecraft weighs around 1500 Kg in low-earth orbit of 650 Km altitude, low inclination (< 8 deg.) circular orbit. The life of the satellite has been configured for a minimum life period of 5 years. Mainframe structure is delivered to clean room and sub systems are being delivered. Propulsion integration has been completed. Payload testing is in progress. Critical Design Review (CDR) of major sub systems and payloads completed.

## 9. INSAT-3 Satellites (including Launch Services)

(₹ in crores)

	Sanctioned Cost	Expenditure to end of March 2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
INSAT-3 Satellites & Launch Services	3119.63	3037.77	25.30	16.00	10.00

9.1 The objectives of INSAT-3 Spacecraft Project are to (i) build five INSAT-3 satellites (INSAT-3A to 3E) keeping flexibility for mid-course corrections to accommodate emerging requirements, carry out mission planning, launch campaign and initial phase operations and (ii) establish required programme elements for carrying out the same. INSAT-3B was launched on March 22, 2000, INSAT-3C on January 24, 2002, INSAT-3A on April 10, 2003 and INSAT-3E on September 28, 2003. INSAT-3D is a state-of-art meteorological satellite with 6 channel Imager and 19 channel Sounder payload. The spacecraft is built around 1-2 K platform with lift-off mass of 2050 Kg with a designed mission life of 7 years. The spacecraft will be located at 82°E longitude in geostationary orbit. The spacecraft has many new elements like the star sensor micro stepping Solar Array Drive (SADA) and the Bus Management Unit (BMU). INSAT-3D spacecraft level assembly, integration and testing activities are completed. The spacecraft was launched onboard Ariane-5 on July 26<sup>th</sup>, 2013. The payload performance is satisfactory and the preliminary images received are of good quality

## 10. INSAT-4 Satellites (including Launch Services)

(₹ in crores)

	Sanctioned Cost	Expenditure end of March 2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
INSAT-4	3597.70	3147.72	97.00	69.35	37.90
Leasing of Transponders	-	-	200.00	48.85	75.24

10.1 The fourth generation INSAT-4/GSAT Satellite series has been planned to meet the capacity and service requirements in the areas of Satellite Telecommunication Broadcasting, DTH, Emergency Communications & Mobile Multimedia Services. The sanctioned cost of the first two satellites in the INSAT-4 series, INSAT-4A & 4B, approved in March 2004 is ₹ 453.00 crores for spacecraft development and ₹ 901.00 crores for Launch Services. The objective of INSAT-4A & 4B Project is to design and develop high power satellites with 12 C-band and 12 Ku-band transponders which will enhance the capacity of the INSAT system considerably. The first satellite in the fourth generation INSAT-4 series, INSAT-4A has been successfully launched on December 22, 2005 from Kourou, French Guyana, which carried 12C-band and 12 Ku-band high power transponders enabling DTH broadcasting. The INSAT-4B has been successfully launched on March 12, 2007 and is identical to INSAT-4A. The replacement satellite INSAT-4CR (cost ₹ 43.20 crores) was realised on fast track mode and launched successfully on September 2, 2007 onboard GSLV-F04.

10.2 The sanctioned cost of INSAT-4C satellite, planned for launch onboard GSLV is ₹ 95.75 crores to carry 12 Ku band transponders. INSAT-4D/GSAT-5 was configured to carry 24 C-band transponders & the total sanctioned cost was ₹ 123.75 crores. The satellite was launched on 25<sup>th</sup> December 2010. However, GSAT-5P could not be placed in orbit due to the failure of GSLV F-06 mission.

10.3 The sanctioned cost of INSAT-4E/GSAT-6, the multi-media satellite is ₹ 269.00 crores. Primary goal of GSAT-6 is to cater to the consumer requirements of providing entertainment and information services to vehicles through Digital Multimedia consoles and to the Multimedia mobile phones. The spacecraft carries a 5 spot BSS and 5 spot MSS. The spacecraft is high power S-Band Communication satellite configured around 1-2K bus with CXS and SXC transponders and lift-off mass of 2200 kg. The spacecraft with a mission life of 12 years is planned to be launched on-board GSLV. All subsystems delivered to AIT and first phase of dis-assembled mode IST completed for mainframe systems. Inspection and revalidation completed for payload panels. Full configuration deployment of unfurlable antenna completed successfully. Thermovac test of unfurlable antenna scheduled to be completed. Payload integration and preparation of second phase of Dis-assembled mode IST is in progress.

10.4 GSAT-8/INSAT-4G Communication Satellite is a state-of-art Satellite, which has 24 Ku band transponders and a two channel GPS Aided Geo Augmented Navigation (GAGAN) payload for (a) augmenting the INSAT System Capacity in Ku-band (b) providing a second Geostationary augmentation payload for the operational phase of GAGAN and (c) providing continued and uninterrupted service. The sanctioned cost of GSAT-8/INSAT-4G Communication Satellite is ₹ 610.00 crores. The satellite was successfully launched on 21<sup>st</sup> May 2011, from Kourou, French Guyana onboard Airane-5-VA-2012.

10.5 GSAT-9 will augment INSAT capacity and act as a stand-by for high-power Ku-band capacity to be provided by INSAT-4A/4B/4CR/4G spacecrafts for Direct-to-Home (DTH) and Very Small Aperture Terminal (VSAT) applications. GSAT-9 is identical to INSAT-4C with 12 high power Ku-band transponders providing India coverage. The spacecraft employs the standard 1-2K structure with the power handling capability of around 3 KW, with a lift off mass of 2195 kg. The sanctioned cost of GSAT-9 is ₹ 140.00 crores Sub system and spacecraft level Critical Design Review (CDR) completed. Layout finalization is in progress. Subsystem fabrication activities are in progress.

10.6 The sanctioned cost of GSAT-10 is ₹ 735.00 crores. The spacecraft carries 12 Ku-Band, 12 C-Band and 12 Extended C-band transponders. The spacecraft employs the standard 1-3 K structure with the power handling capability of around 6 KW with a lift-off mass of 3400 kgs. GSAT-10 Communication satellite has been successfully launched on September 30, 2012 onboard ARIANE-5 launch vehicle from the Kourou launch base in French Guyana and the spacecraft is working satisfactorily.

10.7 GSAT-12, the communication satellite built by ISRO, weighs about 1410 kg at lift-off. GSAT-12 is configured to carry 12 Extended C-band transponders to meet the country's growing demand for transponders in a short turn-around-time. The 12 Extended C-band transponders of GSAT-12, will augment the capacity in the INSAT system for various societal applications like Tele-education, Tele-medicine and Village Resource Centres (VRC). The sanctioned cost of GSAT-12 is ₹ 80.00 crores. GSAT-12 was launched successfully on 15<sup>th</sup> July 2011, onboard PSLV C-17.



## 11. Space Capsule Recovery Experiments (SRE-I & II)

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
88.20	86.95	0.50	0.05	0.25

11.1 The main objective of the Space Capsule Recovery Experiment (SRE) is to develop and demonstrate capability to recover an orbiting capsule back to earth and to carryout micro-gravity experiments in orbit. The recoverable capsule (SRE-I) was successfully launched onboard PSLV-C7 on January 10, 2007 and successfully recovered from the Bay of Bengal after re-entry from orbit on January 22, 2007. SRE-I was a unique mission incorporating several Key technologies such as reusable thermal protection system, deceleration and flotation system, re-entry control and propulsion systems, space qualified parachute systems, locating aids, etc. The successful recovery of SRE-I is a major landmark achievement of Indian Space Programme and it has laid a strong technological foundation for future re-usable launch vehicle systems.

11.2 SRE-II is a follow-on mission to SRE-I to further validate the re-entry technologies. SRE capsule has four major hardware, namely Aero Thermo-structure (ATS), Spacecraft platform, deceleration and flotation system and payloads.

11.3 ATS base structure was realized at CMSE and kept in preservation mode. Six plasma wind tunnel tests were conducted to validate the silica tile repair scheme. To qualify new elements mounted in the base region of SRE II, an integrated test of annular deck was successfully completed.

11.4 Realization of carbon-carbon cap and shell hardware with revised process is in progress at CMSE and external centers. Carbon-carbon cap will be processed as 4D composite through Hot Isostatic Pitch Impregnation & Carbonization (HIPIC) route. Four HIPIC cycles on 1<sup>st</sup> hardware completed and thermal characterization done. HIPIC for the second hardware in progress. Carbon-carbon shell will be processed through 2D Pitch Impregnation and Carbonization route. Carbon-carbon shell processing is under progress at CMSE and external work centers. Interface design of C/C cap and shell revisited based on the new thermo-mechanical properties. SiC coated C/C samples are ready for validation testing at plasma wind tunnel facility.

## 12. Navigational Satellite System

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
1420.00	890.64	135.00	115.00	120.00

12.1 The main objective of the Satellite Navigation program is to establish a regional Indian Satellite Navigation System & explore opportunities for participation in global systems.

12.2 IRNSS is a regional navigation system with a constellation of GEO and GSO satellites. The coverage includes the Indian subcontinent and around 1500 Km beyond the Indian geographical area. IRNSS system

is targeted to provide the dual frequency user with accuracy better than 20 meters in horizontal & vertical position in the coverage area. The IRNSS system mainly consists of Ground Segment, Space Segment and User Segment.

12.3 INC computers and servers installation has been completed. Installation of IRNWT sub-systems is completed at INC, Bhalalu. The space segment consists of a constellation of seven GEO satellites.

12.4 IRNSS-1A, the first of the seven satellites in the constellation was launched successfully on board PSLV-C22 on July 21<sup>st</sup> 2013 & IRNSS-1B, the second of the seven satellites in the constellation was successfully launched on 4<sup>th</sup> April, 2014. The In-orbit Test (IOT) of navigation, ranging payload and TTC transponders has been completed successfully.

12.5 IRNSS – 1C is the third of the seven satellites planned for the IRNSS constellation. The mainframe structure, Payload system, Propulsion systems, Power packages, TMTC packages etc., have been delivered for further integration and tests, Integration of the Propulsion System has been completed. The results are being checked. Thermal implementation on propulsion plumb lines, Dual Helix Array Antenna, reaction wheels and star sensors completed. The launch of IRNSS-1C onboard PSLV-C26 mission is planned in October, 2014.

### 13. Semi Cryogenic Engine Development

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
1798.00	154.92	180.00	65.00	150.00

13.1 The objective of the Semi Cryogenic Engine Development is to power the future heavy lift Unified Launch Vehicles (ULV) and Reusable Launch Vehicle (RLV) of India. This semi cryogenic engine, which uses a combination of cryogenic as well as earth storable propellants, developing a thrust of 2000 kN, is planned as the booster engine for the Common Liquid Core of ULV. This engine uses Liquid Oxygen and Kerosene as propellants. The engine is planned to be developed and qualified over a span of 6 years. In this, the first four years is planned for subsystem development and the remaining two years will be used for development and qualification of the engine. The facilities needed for testing also has to be made ready in 4 years.

13.2 The Preliminary Design Review (PDR) for Semi-cryogenic engine development has been completed. Preparation of fabrication drawings of subsystems have been completed. A MOU has been signed with NPTDC for the realisation of copper alloy for Thrust chamber. Single element Pre-Burner (PB) injector realised and injector spray characterisation using PIV was carried out. Test facility for single element pre-burner commissioned at PRG facility, VSSC. Semi Cryo Test facility design by M/s Rolta has been completed.

13.3 Design of Semi Cryo Engine including heat exchanger and ejector is completed. Fabrication drawings and documents are generated based on the PDR and joint reviews. Configuration design of subscale engine is completed. Preliminary Design Review (PDR) of Hydraulic Actuation System (HAS) and Hydraulic Power System (HPS) for Engine Gimbal control is completed and Technical specifications are finalized.



13.4 Single Element Pre-Burner injector element has been hot tested successfully. Ignition of LOX/Isrosene propellant with hypergolic slug igniter and flame holding, demonstration of safe handling of pyrophoric fluid TEA, validation of start sequence, characterization of injector elements and qualification of Hayness-214 material are the major achievements of the tests. Design of single element thrust chamber is completed and fabrication drawings are generated. Single element thrust chamber injector elements are realized and cold flow tests were carried out. Special pre burner which will provide hot gases for testing the single element thrust chamber has been realized.

13.5 Semi cryo single element thrust chamber ignition trials (3 tests) conducted at SPTF/LMF, which included stage combustion cycle mode test of the injector. Tendering activities are in final stage for award of contract for Engine subsystem fabrication (6 work packages). Assembly & testing of 14 types of control components is completed.

## 14 SARAL

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
73.75	54.98	10.00	11.00	0.00

14.1 The objectives of the Satellite with Argos and Altika (SARAL) Mission are (i) to design and develop satellite bus in the weight range of 400 kg including payloads up to 200 kg mass and (ii) to establish required ground infrastructure for receiving and processing of the ALTIKA payload data within India for ocean related applications. SARAL is a co-operative mission between DOS/ISRO and CNES, France with payloads from CNES and the spacecraft bus from DOS/ISRO. Two payloads namely Altika and ARGOS are planned in this mission. Altika is a Ka band altimeter for ocean applications and ARGOS is a data collection platform for collecting variety of data from ocean buoys to animal behaviour. SARAL is part of international continuing missions using these payloads.

14.2 The spacecraft was successfully launched by PSLV-C20 on February 25, 2013 which carried another 6 Satellites viz., Sapphire, NESaT, 3 nos of NLS-8 series and STRaND.

## 15. GSAT-11 (Advanced Communication Satellite)

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2012	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
500.00	168.92	203.00	140.00	164.50

15.1 The Advanced Communication Satellite is intended to be developed as an advanced multi beam communication satellite, employing a new I-6K Bus proposed to carry 32 Ka X Ku Band- Forward Link Transponders and 8 Ku X Ka Band Return Link Transponders. The spacecraft is having a lift off mass of 5600 kg and the power handling capability of around 13KW. Spacecraft configuration, sub system design and

interfaces are finalized. Spacecraft level preliminary design review completed. Activities for the development of structure and sub-system qualification models are in progress.

## 16. ADITYA

(₹ in crores)

<b>Sanctioned Cost</b>	<b>Expenditure to end of March 2013</b>	<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
127.75	11.96	20.00	5.00	27.00

16.1 The ADITYA-1 Project will be the first Indian Space based solar coronagraph, which will be available for solar coronal observation to all the Indian researchers in the field of Solar Astronomy. The major scientific objective of the ADITYA-1 is to achieve a fundamental understanding of the physical processes that heat the solar corona (base to the extended), accelerate the solar wind and produce Coronal Mass Ejections (CMEs). The proposed scientific goals are to detect and understand (i) the existence of waves in the solar corona and the nature of waves (ii) the role of waves in heating the solar coronal plasma (iii) formation of coronal loops (iv) magnetic nature of coronal loops (v) the pre-eruption dynamics of CMEs and (vi) CME's role in driving the space weather.

16.2 Aditya is primarily designed with the objective of coronal and coronal loop's plasma studies, measurement of coronal magnetic fields, etc. which can be achieved with the re-configured mission. Spectroscopic capability has been added to increase the scientific studies in the absence of high cadence imaging capability. Project proposal and candidate payloads are discussed in ADCOS with five new payloads besides the enhanced coronagraph recommended. Project report is being prepared and all bus elements are defined.

## 17. Geo-Imaging Satellite (GISAT)

(₹ in crores)

<b>Sanctioned Cost</b>	<b>Expenditure to end of March 2013</b>	<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
392.00	33.90	80.00	46.00	63.00

17.1 GISAT is a Geo Imaging Satellite at Geostationary orbit with a high temporal resolution. It has a multispectral imager operating in Visible, Near Infra Red and Thermal Infra Red bands and Hyper Spectral imager operating visible, near infra red and short wave infra red bands. The satellite is primarily meant for near real time imaging of natural resources and disaster management. the spacecraft platform is a derived version of I-1K bus with a power handling capability of around 1.6W with a lift of mass of 850 kg. Preliminary Design Review (PDR) of payload and bus systems completed. Spacecraft level PDR is planned to be conducted during November 2013.

## 18. MARS ORBITER MISSION

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
450.00	122.64	167.50	225.00	71.00

18.1 Mars Orbiter Mission being our first mission to a distant planet is primarily driven by the technological objectives and supplemented by the scientific objectives. The objectives of the mission are (i) design and development of a Mars orbiter with a capability to perform earth orbital maneuvers, Martian Transfer Trajectory and most importantly the Mars orbit insertion/capture after nearly 300 days of travel, (ii) Mission design, planning, management and operations of the Mars Deep Space Mission. (iii) Communication between earth station and orbiter at a distance of nearly 400 Million km.

18.2 Mars Orbiter Mission (MOM) is ISRO's first interplanetary mission to Mars. The primary driving technological objective of the mission is to design and realise the spacecraft weighing around 1355 kg with a capability to survive and perform earth bound maneuvers, cruise phase of 300 days, mars orbit insertion and capture and on-orbit phase around Mars. The science objective is the deployment of scientific instruments for exploration of Mars surface features, morphology, topography, mineralogy and Martian atmosphere. The Mars Orbiter Mission was launched on 5<sup>th</sup> November, 2013.

18.3 Subsequently, the Mars Orbiter was placed in Trans Mars trajectory through critical orbital manoeuvres. Presently, the Mars Orbiter spacecraft is on its long voyage to planet Mars through a helio-centric trajectory. The Mars Orbit Insertion (MOI) manoeuvre is scheduled to be performed on 24<sup>th</sup> September, 2014.

## 19. GSAT-15 SATELLITE (INCLUDING LAUNCH SERVICES)

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
859.50	0.00	400.00	247.20	488.00

19.1 GSAT-15 is a communication satellite planned to be positioned at 93.5°E with a lift of mass of about 3150 Kg and 6.5KW power generation capacity. It is designed for a mission life of more than 12 years. The satellite will carry 24 Ku Band Transponders and two channel GAGAN payload. Project approval received and all major reviews completed. The mainframe structure has been delivered for further integration and test. Propulsion module integration is in progress. Hardware in Loop Simulation (HILS) test is in progress. The launch of GSAT-15 satellite is planned by the first quarter of 2015-16 through procured launch service.

## 20. GSAT-16 SATELLITE (INCLUDING LAUNCH SERVICES)

(₹ in crores)

Sanctioned Cost	Expenditure to end of March 2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
865.50	0.00	400.00	296.20	543.00

20.1 GSAT-16 is a communication satellite configured around I-3K extended bus with a lift off mass of 3150 Kg and 6.5 KW power generation capacity and mission life of more than 12 years. The satellite carries 12 Ku, 24 Normal C and 12 Extended C Band transponders. Payload integration has been completed. All panels of the satellite have been closed. Closed mode Integrated Satellite Testing is in progress while characterisation of payloads and testing of Bus system have been completed. The launch of GSAT-16 satellite is planned through procured launch service provider, Arianespace (France). Based on the schedule information by the launch service provider, the launch of GSAT-16 is planned during second half of 2014.

## DEPARTMENT OF SPACE/ISRO CENTRES/UNITS

### 21. Vikram Sarabhai Space Centre (VSSC)

(₹ in crores)

Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
732.87	711.00	988.67

21.1 VSSC, located around picturesque Veli Hills near Thiruvananthapuram, is the lead Centre responsible for the design and development of launch vehicle technologies, sounding rockets and associated technologies for the Indian Space Programme. The Centre pursues Research and Development in the fields of Aeronautics, Avionics, Composites, Computer & Information, Control, Guidance & Simulation, Launch Vehicle Design, Mechanical Engineering, Mechanisms, Vehicle Integration and Testing, Propellants, Polymers, Chemicals, Materials, Propulsion, Space Ordnance and System Reliability. Activities like Programme Planning & Evaluation, Construction & Maintenance, Safety, Personnel and General Administration support the centre's core functions. The mandate for VSSC is:

- Research and Development for ongoing and future space transportation systems of ISRO.
- Multiple missions as per ISRO's launch manifest.
- Ensuring Low cost access to Space.

## 21.2 Major Achievements during 2013-2014

- Successful launches of PSLV-C22 with India's first indigenous Regional Navigation Satellite IRNSS-1A on 1st July 2013 and the PSLV-C25/Mars Orbiter Mission on 5<sup>th</sup> November 2013;
- For the GSLV, commissioning trials of High Altitude Test facility at LMF were carried out followed by successful cold start test and two hot tests of cryo engine;
- CUS-05 flight stage was realized. All activities towards the GSLV-D5 were completed towards the launch planned on 19<sup>th</sup> August 2013. However, the launch was called off at T-1:30:00 Hrs on noticing UH-25 leakage;
- A High Level Task Team was constituted to give recommendations to restore GSLV D5 vehicle to flight configuration. The project has taken action to realize all the additional stages as per the recommendations of High Level Task Team. All the additional stages are realized and positioned at SDSC-SHAR. Launch campaign has re-commenced on 18<sup>th</sup> October 2013 with a launch target of 15<sup>th</sup> December 2013. The GSLV D5 was successfully launched on 5<sup>th</sup> January, 2014;
- Ground Resonance Test of GSLV Mk-III in full vehicle configuration has been carried out. All environmental qualification tests of sub assemblies have been completed. Structural qualification test of 5 m diameter Heat shield has been completed. Functional qualification tests of S200, L110 and Space craft separation systems and pyros are completed. Preparations towards the functional separation test of heat shield are also progressing well. C25 integrated engine test is planned during 2014-2015;
- The first experimental sub-orbital flight test (LVM3-X) with passive C25 stage is planned in the last quarter of 2013-2014;
- RLV-TD - High altitude Radar Altimeter balloon test with silica tiles was successfully conducted up to an altitude of 700 m at TIFR;
- Wind tunnel testing of 1:1 FADS model was conducted at IIT, Kanpur. Avionics Bay powering was carried out through OBCC for the Avionics packages in the TDV;
- ATS base structure for the SRE-II was realized at CMSE and kept in preservation mode. Six plasma wind tunnel tests were conducted to validate the silica tile repair scheme. To qualify new elements mounted in the base region of SRE II, an integrated test of annular deck was successfully completed. Realization of carbon-carbon cap and shell hardware with revised process is in progress at CMSE and external centers.;
- Crew module has been realized for Flight testing in LVM3-X mission.
- Environmental Simulation Chamber commissioned for testing of ECLSS functional modules and flightsuit systems;
- Detailed mission studies were carried out for the scramjet engine flight. Qualification model and flight model of newly developed Scramjet Engine Avionics Module and scramjet engine frame assembly for flight were realized;

- Towards Scramjet combustor ground testing facility, fluid flow trials in manual/automatic mode were carried out on Gaseous Oxygen, Air and Gaseous Nitrogen supply systems;
- Spin qualification test of XTA system for ATV D02 vehicle was successfully completed;
- Six RH200 flights with chaff payload were successfully conducted from TERLS Range for collecting MET data;
- Major facilities established include the 5 TPD sodium chlorate Plant at TCC, Kochi, Hot Isostatic Press, Actuator Production Facility, 3 axis CNC Vertical Milling Machine, High Temperature Sintering Furnace, 5-axis Gantry Milling Machine, Thermo Gravimetric Analyzer/Thermal Desorption GC Mass Spectrometer, Cryostat facility, Propellant casting facility, Laser Spot Welding machine for Bridge wire welding of initiators and Pyrogen igniter facility;
- Six patents have been granted during the year.

### 21.3 Major Activities Planned during 2014-2015

- 3 PSLV missions are scheduled with IRNSS series of satellites (IRNSS-IB, IC & ID) that will enable commissioning of Indian Regional Navigation Satellites system;
- Proposed to launch GSLV-D6 mission carrying GSAT-6 Satellite;
- Proposed to launch the first experimental flight of GSLV MkIII with passive cryo stage (LVM3-X Mission) in the first quarter of 2014;
- Crew Module flight in LVM3- X mission
- Flight integration and launch of RLV-HEX 01 mission;
- Launch of ATV D02 vehicle with active air breathing engine modules and fuel feed system during March 2014 from SDSC-SHAR;
- Realisation and qualification of Crew Module for PAT and realisation of facilities at SDSC-SHAR for PAT;
- Development tests of ECLSS subsystems in Cabin Environment Simulator;
- Realisation and qualification of flight worthy scramjet engine modules and high pressure Gaseous Hydrogen Fuel Feed System to demonstrate supersonic combustion in high speed flight conditions;
- Major facilities to be commissioned include Advanced Thermovacuum Facility, Nozzle & Combustor Testing Laboratory, Detonics Research Laboratory, Powder Metallurgy Facility, Advanced Electronic Ceramic Laboratory, 5 and Fastener Storage & Automated Retrieval Facilities.

## 22. ISRO Inertial Systems Unit (IISU)

(₹ in crores)

<b>Budget 2013-2014</b>	<b>Revised 2012-2014</b>	<b>Budget 2014-2015</b>
69.01	68.00	76.88

22.1 The ISRO Inertial Systems Unit (IISU) situated at Thiruvananthapuram is responsible for research and development of Inertial Systems for both Launch Vehicles and Spacecraft programmes of ISRO. IISU also designs and develops Actuators and Mechanisms for Spacecraft and allied applications.

22.2 The Unit is organised into Research and Development divisions in the fields of Launch Vehicle inertial systems, Spacecraft inertial systems, advanced inertial system, Bearing and Space Tribology, Inertial system production and Reliability & Quality assurance. Many TDP & R&D activities are carried out in the fields of inertial sensors, systems and various spacecraft mechanisms, to reduce size, volume, power, weight, costs and also to increase accuracies, durability, life, redundancy and flexibility in operating environments. IISU is also equipped with facilities for precision fabrication, assembly & clean room, integration & testing of Inertial sensors, Systems and Actuators.

### 22.3 Major Achievements during 2013-2014

- Delivered launch vehicle Inertial Systems (RESINS, RPG and GAINS) for PSLV-C25, RLV-TD (RESINS MKIV R-QM) and GSLV-MK3 (RESINS MKIVA-QM) missions ;
- Delivered Spacecraft Inertial Systems (IRU, Wheels and SADA) for IRNSS-1B, 1C, GSAT-15 (IRU) and MARS Orbiter Mission (Spare – IRU and Wheel) missions;
- Completion of launch campaign and post flight analysis of PSLV-C22 mission;
- RESINS MKIV A Test and Evaluation is completed and ready for delivery to the project;
- AINS FM-01 realised for the piggyback testing in PSLV C23. Acceleration Measurement Package (AMP) realized for ATV-D02. Temperature Sounder Scan Mechanism (TSSM) EM realized and delivered to SAC for integrated testing;
- The following TDP activities have been completed :-
  - Realized qualification model of HDAS for RLV-TD;
  - Realisation of FPGA based SADA ;
  - Realisation of miniature IRU;



- Completed the installation and commissioning of :-
  - 3-Axis Angular Motion Simulators (2 Nos.);
  - EMI test facility;
  - High speed ultrasonic machining center;
- Planned to deliver launch vehicle Inertial Systems for PSLV C23, PSLV C24, PSLV C26 and GSLV D6;
- Planned to deliver Spacecraft Inertial Systems for GSAT-15 (SADA), GSAT-16 (SADA), GSAT-9 (IRU,SADA), GSAT-11, IRNSS-1D, 1E and INSAT 3DR (Sonder Scan Mechanism and Filter Wheel Drive);
- Planned to realize RESINS MkIVA FM, Standby for GSLV Mk3, RESINS MkIVR FM, Standby for RLV-TD and two systems of AINS 200;
- The installation and commissioning of the following test facilities are planned to be completed before March, 2014
  - High precision jig boring machine for CTTC, Bhuvaneswar;
  - Precision CNC turning centre at SMMF, Mumbai;
  - High accuracy co-ordinate measuring machine;
  - Thermo vacuum chambers with inertia simulation for high power SADAs of I-4K/I-6K Spacecrafts;
  - Establishment of structural characteristic Lab;
  - PIND testing facility, gross leak detector and centrifuge for component screening;
  - 2-Axis Position/Rate table for sensor testing;
  - Single Axis Position/Rate table for designer level testing of IRUs;
  - LCO2 storage facility for 3-Axis AMS with thermal chamber;
  - Temperature sensors calibration facility for sensors used in thermo vacuum systems;
  - LN2 storage tank of 6000 litres capacity for thermo vacuum applications;
  - High power thermal circulator for Spacecraft applications.



## 22.4 Major Programmes for 2014-2015

- Planned to realize flight and standby systems of RESINS and GAINS for PSLV C26, PSLV C27, GSLV D6, GSLV F07, PSLV C28 & PSLV C29 missions;
- Planned to realise RGPD for 4 PSLV Missions & 2 GSLV Missions;
- Planned to realise Inertial Systems (IRU,Wheels, WDE & SADA) for GSAT-6, GSAT – 7A, GSAT – 11, IRNSS-1C, IRNSS – 1D, IRNSS – 1E, IRNSS-1F, RESOURCESAT-2A & INSAT 3DR missions;
- Planned to realise EM of Rotary Transducer, High performance Navigation processor, Redundant TMR MEMS Rate Gyro Package;
- Planned for miniaturization of Wheel Drive Electronics using Power HMC and TCS HMC;
- Planned for qualification High Power SADA for GSAT-11;
- Planned to develop and realize HRG shell / QM for Control Moment Gyro (QM);
- Planned for lab level validation of atom interferometric Sensor;
- The following major facility augmentation activities are planned during 2014-2015:-
  - Single Axis Rate Table with Thermal Chamber
  - Laser Lithographic System
  - Precision CNC Turning Centre
  - Ultrasonic cum High Speed Machining Center
  - CNC Optical Grinding machine
  - High accuracy co-ordinate Measuring Machine
  - Vibration / Shock Response System
  - Precision Dividing Head

## 23 Liquid Propulsion Systems Centre (LPSC)

(₹ in crores)

<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
439.09	346.00	278.05

23.1 The Liquid Propulsion Systems Centre (LPSC), with its facilities located at Thiruvananthapuram (Valiamala), Mahendragiri and Bangalore is the lead Centre in the area of liquid propulsion encompassing earth storable and cryogenic propulsion systems for launch vehicle and spacecraft programmes. The launch vehicle engine and stage design activities are carried out at its facilities at Valiamala. Spacecraft propulsion systems engineering, mono-propellant thruster development and transducer production activities are carried out at its facilities at Bangalore. Earth storable and cryogenic engine and stage facilities, assembly and integration of engine and stages for launch vehicles, propellant storage and Liquid Hydrogen production facilities are located at Mahendragiri.

### 23.2 Major Achievements during 2013-2014

- CUS 05 Flight Stage was flagged off to SDSC-SHAR for GSLV D5 Mission on 13<sup>th</sup> May, 2013. CUS 05 stage servicing operations were carried out as part of GSLV D5 launch count down;
- Second HAT test with sequence shift (100 ms advancement of Main Engine LOX injection valve) was successfully conducted & demonstrated the engine build up with the modified start sequence;
- Completed CUS Modified Fuel Booster Turbo Pump (FBTP) Repeat Qualification Tests. With this, endurance test on single hardware (through multiple tests in standalone mode) for double the flight duration is completed & margin demonstrated;
- In respect of CUS 06 Flight Stage realization for GSLV D6 Mission, the Stage systems viz. propellant tanks & structures, level sensor, propellant acquisition system etc., realized. Flight assembly of Oxidizer & Fuel Booster Unit completed. System level assembly/test activities are in progress for engine systems;
- CE20 Thrust chamber LH2 flow trials conducted at TCT/LMF & finalized the sequence for the ignition trials. CE20 first integrated Engine (E1) – Gas Generator & valve system assembly, Turbo Pump & GG feed system assembly with TC trial etc., completed. In respect of C25 Passive Stage for LVM3 X Flight, LH2 & LOX Propellant tanks PPT completed & insulation in progress. Dummy Engine cleared for flight. Realisation of polyimide lines, interface elements etc., in progress. C25 LH2 auxiliary umbilical is ready for qualification tests. LOX tank for structural test realised and proof pressure tested for the C25 Stage Systems. Integration and delivery of passive C25 stage for LVM3-X flight is planned during the year;
- L110 Stage functional assembly is in progress at LMF. Functional assembly of engines, Propellant tanks, Inter Tank Structure (ITS), Inter Stage (IS1/2L) & Core Base Shroud (CBS) completed. Electromechanical actuator qualification tests conducted at engine level. AA 6061

water tank realized. L110 sit on umbilical qualification test conducted. The realization and delivery of flight stage for LVM3-X flight is planned during the year;

- Semicryo single element thrust chamber ignition trials conducted at SPTF/LMF, which included stage combustion cycle mode test of the injector. For Engine subsystem fabrication, tendering activities are in final stage for award of contract. Assembly & testing of 14 types of control components have been completed;
- PS2, PS4 Stages & control power plants performed satisfactorily during the PSLV C22 mission. PS2 & PS4 stages & Control Power Plants delivered for PSLV C25 mission. GS2 and L40 stages delivered for GSLV D5 and launch campaign activities carried out. Due to launch call off, the stages were de-stacked to be replaced with fresh stage assembly. Fresh GS2 stage assembly is in progress at LMF. L40S4 & L40S3 Stages already positioned at SDSC-SHAR. L40S2 is ready at M/s. ASD/HAL & L40S1 stage integration in progress at M/s ASD/HAL;
- Integrated propulsion system delivered for INSAT-3D, GSAT 7 & GSAT-14. For orbit raising, LAM was fired for a cumulative duration of 5564.9 s during INSAT-3D mission & 7080s during GSAT 7 mission, which marked the 25<sup>th</sup> successful mission with indigenous 440 N LAM. GSAT 14 propulsion system is kept under preservation for the forthcoming GSLVD5/GSAT 14 mission;
- LAM Simulation tests conducted at Sea level & HAT conditions to demonstrate the performance after long duration exposure to propellant under pressure as well as propellant vapour/traces. Sea level & high altitude simulation tests in liquid phase completed & vapour phase tests are in progress. Satellite propulsion system integration for MARS orbiter mission completed;
- Propulsion system performed successfully in the IRNSS 1A mission. LAM engine was fired for a cumulative duration of 4606 s.;
- High performance PS4 engine sea level hot test conducted for 665s duration. With this 91 hot tests in 5 h/w for 5820s cumulative duration completed & 7s improvements in Isp achieved. Indigenous Cryo Turbo pump proto bearings tested up to 42,000 rpm with LN2. Vortex combustion technology, Pulsed Plasma Thruster (PPT) technology etc., was demonstrated. Nano heat transfer studies using Al<sub>2</sub>O<sub>3</sub> / ISROSENE nano fluid completed. MEMS absolute pressure transducer flight tested. Qualification of 3 in 1 MEMS absolute pressure transducers completed. Advanced satellite pressure sensor with digital output proto model tested. CFD Analysis for LH2 Cold Flow Trial of CE-20 Engine in TCT Facility completed. Plume impingement analysis carried out for 22 N AOCS thruster for GSAT-14 spacecraft, MARS and Lunar Lander;
- CUS main pump casing realized through forged machined route as an alternate for casting. Implemented broaching for spline cutting of Vikas engine water pump impeller. Duplex Sealing implemented in anodisation of Vikas engine Al Alloy components for better results;
- Production of VIKAS engines, cryo engines and PS4/RCT engines, satellite thruster parts etc., are continued through industry. 100th PS4/RCT engine delivered from industry. L40 conical Thrust Chambers realized through alternate source. Alternate Work Centre is identified for CUS main engine injector elements. Propellant tanks, structures & other stage elements production

continued through industry for earth storable and cryogenic application. An alternate work centre for cryo engine fabrication is identified with M/s. ASD/HAL. L40 Stages integrated at L40 integration facility at M/s. HAL and delivered for GSLV mission. CE20 thrust chamber fabrication at M/s. BATL is in progress as an alternate work centre. Components & modules production is continued through M/s. MTAR and M/s. LTE. End-to-end production contract for satellite propulsion components entered into with M/s. MTAR, Hyderabad. Contract signed with M/s LTE for production of 21 NA Pressure transducers & Differential Pressure Transducer & is in progress. Production of earth storable propellants & Liquid Hydrogen at industry continued to meet Launch Vehicle and Satellite programme. AA 2219 propellant tank for PS2/ GS2 productionised;

- Indigenized PS4 engine universal joint, DC torque motor for PSLV SITVC injection valves, DC geared motor & electrical actuator for motor operated valves for PSLV & GSLV, 1W catalyst bed heater for Monopropellant Thruster, propellant acquisition system for CUS, 769L propellant tank for GEOSAT, Titanium Alloy: BT3-1, Steels: 06X15H6MBΦ (15-5PH), 03X12H10MTP (12-10PH), 12X21H5T (12Cr21) & 38XA, 09X16H4B, 20X13, 15X18H12C4T & Steel 45, Magnetic Material: 11-16X & Soft iron (10880) for Semicryo, Scroll casing casting for CUS Fuel Booster Pump (FBTP), Cu-Cr-Zr-Ti Copper alloy rods for CUS Steering engine, Cu-Cr-Zr-Ti Copper alloy rods for Semicryo, indigenous EPDM 'O' ring for CUS Fuel Booster pump, AS7G03-Y23 Al alloy castings, ICSS-1418-201C LH2 main pump casing for CUS & Copper wire filler wire of Dia.1.2mm ;
- Augmentation of Main Engine & Stage Test stand (MET) for C25 stage test is completed. Cryo Subsystem Test (CST) facility installation completed. New Cryo Stage integration facility is established. Second insulation processing facility for cryo propellant tanks is commissioned. Auxiliary Test Stand augmentation for cryo auxiliary umbilical tests completed. Bearing & seals test facility commissioned at Valiamala. New cryogenic test facilities viz. second MET and Cryo Turbo Pump Test facility (CTPT) is under planning at LMF. Scope & test requirements were reviewed & finalized. Detailed project report made with an outlay of Rs 800.00 Cr for second MET & Rs 90.00 Cr for CTPT. Semicryo 110 KV substation commissioned at LMF.

### **23.3 Major Activities Planned during 2014-2015**

- Planned to complete integration & delivery of CUS 06 and CUS 07 flight stages for GSLV mission;
- Planned to complete development test of first integrated engine (S/L) at MET. CE20, realization of integrated engine (3 Nos.), engine development tests at TCT-HAT facility, integration of engine for Developmental stage & acceptance tests at TCT facility and stage integration for ground development test;
- Planned to realise hardware for first & second development flight stage and assembly of stage systems for Developmental flight- D1;

- Planned to complete sub scale thrust chamber hot test, realisation of engine subsystems, completion of indigenous development of raw materials and realization of booster turbo pump & cold flow test;
- Planned for the realization and delivery of PS2, PS4 stages and control Power Plants (CPP) for PSLV continuation programme & launch campaign activities;
- Planned for the realization and delivery of GS2 stage and L40 stages (through industry) for GSLV continuation programme & launch campaign activities;
- Planned to deliver integrated propulsion systems for satellite mission & launch base support;
- Planned for integration, testing & delivery of SITVC & RCS flight package for the first HEX mission;
- Planned to develop hydrostatic lift-off seals for cryo turbo-pump, Cryo flow meter, demonstrate nano heat transfer technology for semicryo, Dual Bell Nozzle design validation through hot tests, MEMS based temperature sensor, Sensor Networking, development of satellite thrusters with green propellants etc. Annular ejector technology demonstration for HAT, demonstrate variable flow control valve for throttleable engine and develop motor operated cryo valves;
- Continuation of L40 stage integration and production of Vikas Engine, Cryo engine, pressure fed engines, propellant tanks & stage interface elements, feed lines etc., through industry;
- Production of transducers, satellite thruster parts, tankages & feedlines, end to end production of spacecraft propulsion components, satellite pressure vessel parts etc., production of cryogenic control components, integrated production of fluid control components, satellite propulsion components & sensors through industry, integrated production of injection valves & gear box assembly actuators, establishment of alternate production plant for  $N_2O_4$  and production of  $LH_2$  through industry;
- Planned to establish semicryo fluid control components assembly & integration facility at LPSC-V, materials lab and combustion research lab & spin test facility at Valiamala;
- Planned to commission Scramjet Propulsion Test Facility (SPTF) at LMF, high power SPT test facility at LPSC (B) and semicryo cold flow test facility & bulk storage facility;
- TCT augmentation for semi cryo subscale engine test, design & detailed engineering of new facilities viz. Second MET, Cryo turbo Pump Test facility, New PS4 engine facility, II LAM facility etc.,
- Planned to commission semicryo cold test facility and bulk storage facility;
- Planned to establish combustion research lab & spin test facility at Valiamala.

## 24. ISRO Satellite Centre (ISAC)

(₹ in crores)

<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
356.80	296.00	369.16

24.1 The ISRO Satellite Centre (ISAC) at Bangalore is the lead Centre for Satellite Technology. ISAC is carrying out conceptualization, design, fabrication, testing and integration and in-orbit commissioning of satellite systems through time bound projects. ISAC is functionally organised in six major areas: Mechanical Systems Area, Digital & Communication Area, Integration & Checkout Area, Power Systems & Avionics Production Area, Controls & Missions Area and Reliability & Components Area. Electronic and Mechanical fabrication facilities, Environmental test facilities support the centre in fabrication and testing activities. Programme Planning and Evaluation Group is responsible for all planning and acts as the central coordinating agency and technical secretariat of Director of the Centre. Space Astronomy Group has been involved in optical, X-ray and Gamma ray astronomy research with strong emphasis on instrumentation. Computer and Information Group is responsible for establishment and management of centralised IT infrastructure in ISAC. Avionics Production Division is the nodal agency for production of standardized electronic packages. Three Programme Management Offices coordinate the implementation of the INSAT, IRS & Small satellites and Navigation Programmes. CMD is responsible for planning, execution and maintenance of all civil works related to centre.

24.2 ISRO Satellite Integration and Test Establishment (ISITE) functioning under ISAC is equipped with state-of-the-art clean room facilities for spacecraft integration and test facilities including 6.5M Thermo-Vacuum Chamber, 29T vibration facility and Compact Antenna Test Facility under one roof. Assembly Integration and Testing of all communication & Navigation Spacecraft is carried out at ISITE. A dedicated facility for productionisation of standardized sub-systems has been established at ISITE.

### 24.3 Major Achievements during 2013-2014

- Completed spacecraft level assembly, integration and testing activities for INSAT-3D satellite. The spacecraft was launched onboard Ariane - 5 on July 26<sup>th</sup>, 2013. Payload performance is satisfactory and the preliminary images received are of good quality;
- Completed spacecraft level assembly, integration and testing activities for GSAT-7. The spacecraft was launched onboard Ariane – 5 on August 30<sup>th</sup>, 2013. The spacecraft performance is satisfactory;
- Spacecraft level assembly, integration and testing activities completed for IRNSS-1A. The spacecraft was launched onboard PSLV-C22 on July 1<sup>st</sup>, 2013. The In-orbit Test (IOT) of navigation, ranging payload and TTC transponders have been successfully completed;
- Completed spacecraft level assembly, integration and testing activities for GSAT-14. completed and the spacecraft was shipped to SDSC-SHAR on 22<sup>nd</sup> July 2013 for launch onboard GSLV-D5. Prelaunch activities of the spacecraft were completed at the launch base;



- In respect of GSAT-6 satellite, all subsystems delivered to AIT and first phase of dis-assembled mode IST completed for mainframe systems. Inspection and revalidation completed for payload panels. Full configuration deployment of unfurlable antenna completed successfully. Thermovac test of unfurlable antenna scheduled to be completed. Payload integration and preparation of second phase of Dis-assembled mode IST in progress;
- Project approval received for GSAT-16 and all major reviews completed. Mainframe structure delivery to AIT and propellant tank integration completed. Payload integration in progress at SAC, Ahmedabad. Sub system fabrication in progress;
- Sub-system and spacecraft level Critical Design Review (CDR) completed for GSAT-9. Layout finalization is in progress. Subsystem fabrication activities are in progress;
- Spacecraft configuration, sub system design and interfaces are finalized for GSAT-11. Spacecraft level preliminary design review completed. Activities for the development of structure and sub system qualification models are in progress;
- In respect of IRNSS Ground Segment, the navigation software has been installed. Navigation signal performance analysis being performed using payload test receivers (PTR). Laser ranging successfully performed from Yaragadi Station, Australia;
- GPS Aided GEO Augmented Navigation (GAGAN) Certification programme is in final stage. GAGAN signal is now available from GSAT -10 with PRN 128 for users. Infrastructure development for New Delhi Indian Land Uplink Station (INLUS) is completed. Installation and testing and evaluation of Radio Frequency Unit (RFU) at New Delhi INLUS completed;
- Mainframe structure for Astrosat is delivered to clean room and sub systems are being delivered. Propulsion integration has been completed. Payload testing in progress. Critical Design Review (CDR) of major sub systems and payloads completed;
- In respect of CHANDRAYAAN-2, the spacecraft reconfigured in view of indigenous Lander and delta PDR of revised configuration is planned. Detailed design of structural elements of orbiter and lander is in progress. Six wheel rover configuration assembly completed and fabrication is in progress. Tests on development model of rover is in progress;
- Project proposal and candidate payloads for Aditya are discussed in ADCOS with six new payloads recommended. Project report is being prepared and all bus elements are defined;
- Structure for Resourcesat-2A delivered to cleanroom and RCS integration activities are in progress. Mainframe sub - systems realisation is in progress. Development of payload systems is in advanced stage;
- Critical Design Review of mechanical systems for Space Recovery Experiment-2 (SRE-2) completed. Flight subsystem realisation is in progress. Propulsion integration is in progress;

- Taken up technology development programs for future missions like Rendezvous & docking, CARTOSAT-3, Human Space Programme, I-6K high power high throughput bus development, GISAT etc., to meet technology requirements;
- Towards campus expansion, Space science instrumentation facility, MSGE building, terrain test facility and RF anechoic chamber at ISITE are made operational. The construction activities for HDI facility, Assembly integration and testing facility at Space Park and Wet probe test facility at ISITE are in progress;
- Multi Junction solar cell fabrication facility proposal put up to SPAC for approval.

#### 24.4 Major Programmes for 2014-2015

- Planned to complete assembly, integration & testing of IRNSS-1C /1D, GSAT 16 / 11, and ASTROSAT. The launch of these spacecrafts are planned during the year;
- Planned to complete subsystem fabrication for GSAT-9 /15/17, GISAT, INSAT – 3DR, RESOURCESAT-2A, Cartosat-2E, CHANDRAYAAN-2 and IRNSS spacecraft;
- Planned to obtain GAGAN Certification for operational service in aviation sector;
- Planned to realise technologies for future spacecraft viz., Cartosat-3, I-6K bus development, Interplanetary missions and HSP;
- Planned to establish HDI Facility and AIT Facility at Space Park in ISITE.

#### 25. Laboratory for Electro-Optics Systems (LEOS)

(₹ in crores)

<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
38.60	35.00	60.13

25.1 The Laboratory for Electro-Optics Systems (LEOS) at Bangalore is responsible for design, development and production of electro-optics sensors like earth sensors, star sensors, sun sensors, magnetic sensors, temperature sensors and optical gyros for spacecraft use. LEOS is also responsible for the fabrication of various types of optics for satellite cameras & radiometers and development of indigenous detectors for spacecraft. LEOS is also involved in the development of miniature sensors Micro Electro Mechanical Sensor (MEMs) devices, development of Charge Coupled Devices (CCD), Time Delay Integration (TDI) devices with industry participation.



## 25.2 Major Achievements during 2013-2014

- Integration of sensors and Optics for IRNSS-1A, INSAT-3D and GSAT-7 with satellite and tested. Also provided pre-launch and post-launch support to these satellites;
- Integration of sensors for GSAT-15, Astrosat and Mars Mission with satellite and tested;
- Test and evaluation of sensors for GSAT-16, SRE-2, Resourcesat-2A, GSAT-6, GSAT-11, Chandrayaan-2 and IRNSS-1B are under progress;
- Fabrication and testing of sensors and electronics for GSAT-9, Cartosat-2C/2D, Aditya-1 and Cartosat-3 spacecrafts have been initiated;
- Planned to launch Mars Mission, IRNSS-1B and GSAT-14;
- Single axis FOG is delivered to GSAT-14 and completed satellite tests;
- Completed qualification tests of APS based star sensor;
- MEMS based inclinometer for Chandrayaan-2 Rover is under Test & Evaluation;
- Completed first phase of qualification test & evaluation of Indigenous thermistor bolometer and its performance in Earth Sensor demonstrated;
- Lyman Alpha Photometer (LAP) delivered to Mars Satellite. EMI nad EMC test on qualification model completed;
- Completed baseline design of indigenous high energy LASER source (100mj and dual wavelength) for LIDAR applications. Completed procurement of all Optical & Electronics components;
- LIBS for Chandrayaan-2, Color camera & image storage unit for SRE-II and Navigation Camera for Lunar Rover are under development;
- 'Astrosat' optics both NUV and FUV are integrated with payload and integrated level testing completed;
- Telescope optics for Cartosat-2C and Cartosat-2D are under final stage of testing;
- Primary mirror & secondary mirror of High Resolution Optics (HRC) for Cartosat-3 under realisation;
- LISS-III, LISS-IV and AwiFS Optics for Resourcesat-2A are under testing;

## 25.3 Major Programmes planned for 2014-2015

- Planned to complete Satellite integration level testing of sensors and launch of GSAT-6, IRNSS-1C, IRNSS-1D, GSAT-15 & Astrosat;
- Planned to develop Sensors and Optics for GSAT-11, Cartosat-3 and Chandrayaan-2;
- Planned to develop Laser Induced Breakdown Spectroscopy (LIBS) payload and Camera for Land Rover;
- Planned to develop Indigenous Laser Source for LIDAR and Laser Induced Breakdown Spectroscopy (LIBS) for lunar & interplanetary missions, Silicon Carbide (SiC) optics technology, Navigation Cameras for Lunar Rover (Chandrayaan-2) and Space Grade color Camera and image storage unit for SRE-2;
- Spectroscopy for optical material analysis and development of solar coronagraph optics for ADITYA-1 are under progress;
- Planned to establish new Facilities such as Magneto-Rheological Finishing (MRF) facility, Ultra-Precision CNC Centering and turning Machine, Lens Centering and Edging Machine, New Lens Centering and Edging Machine, Ultra-Precision CNC Centering and turning machine & High Resolution VUV Spectrophotometer;
- Planned to procure new Cell centering machine, Three Axes CNC milling machine, CNC Wire cutting machine, Atomic Force Microscope, Dual Ion Beam Power Supply and Augmentation of New Coating Plant.

## 26. Satish Dhawan Space Centre (SDSC-SHAR)

(₹ in crores)

<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
457.83	411.00	508.30

26.1 Satish Dhawan Space Centre-SHAR (SDSC-SHAR) is the principal operational Centre for launching Sounding Rockets and Satellite Launch Vehicles. The activities at SDSC-SHAR are grouped under vehicle assembly & static test operations, range operations, liquid storage & service facilities and solid propellant booster plant. The main facilities in the Centre include those for production of solid propellant rocket boosters, ground and environmental qualification of rocket motors and their sub-systems, integration, check-out and launch of satellite launch vehicles, liquid propellants & cryogenic propellants storage and servicing facilities, tracking & telecommand stations, real-time data processing and range & flight safety.

## **26.2 Major Activities Completed and Planned during 2013-2014**

- Completed the preparation and integration activities of Launch vehicles and servicing & launch of PSLV C22, launch of GSLV D5 was attempted and called off. Works completed for launch activities of GSLV D5 as per revised plans. Preparations are in progress for PSLV C23 mission. Preparation, integration and Launch activities of GSLV Mk-III-X / Care Mission are planned;
- At the S200 Production plant, as part of S200 third static test two segments processed and processing of third segment is planned;
- As part of infrastructure development, a new L40 storage facility and PSO/PSO-XL preparation facility are being realized;
- As part of bulk storage augmentation MMH & MON3 is being realised and Standby PTUs are realized. A dedicated control system realised for 24X7 monitoring Safety systems;
- As part of production plant augmentation New Second Casing & Curing facility and Machining facility is being realised. A new 4.5 ton vertical mixer is being realized;
- Liquid Hydrogen Tank (with liquid nitrogen shielding) with 40 Cu.M capacity is being realised as part of R&D / TDP;
- As part of Multi Object Tracking Radar (MOTR) realization, technology demonstrated with a Subscale version of the Antenna. Realization works commenced for main MOTR and procurement action nearing completion for major sub systems of Main MOTR;
- Second Vehicle Assembly Building has been approved by the Department and initiated the preliminary project works;
- A new security division is created for strengthening the security works in the Centre as part of implementing the multi layer security system. Marine police station building is realised and Coastal security works in progress. Biometrics for entry/exit system and realisation of seaward surveillance system is planned;

## **26.3 Major Activities Planned during 2014-2015**

- To meet the increased launch frequency requirements; required facilities augmentation is being carried out right from Solid Motor production, Stage Preparation facilities, Integration facilities, Satellite preparation facilities, Propellant Servicing systems, Range operations systems, etc., for simultaneous preparation and launch of two launch vehicles at any given point of time. This will enable the Centre to meet the increased launch frequency requirements up to 8 launches per year;

- Proposed to commence works relating to:-
  - Second Vehicle Assembly Building.
  - Machining Facility at SPP.
  - Bulk Storage Augmentation for UH25 & N<sub>2</sub>O<sub>4</sub>.
  - Replacement of Control System at SLP.
  - Realization of Planetarium.
- Proposed to commission:-
  - Second Casting & Curing Facility.
  - Full scale version of Multi Object Tracking Radar.
- Production of solid motors for PSLV/GSLV Mk2 & LVM3;
- Stage Preparation, Integration and launch of PSLV/GSLV Mk2 & LVM3 vehicles as per launch manifesto.

## 27. ISRO Telemetry, Tracking and Command Network (ISTRAC)

(₹ in crores)

Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
129.26	130.00	157.04

27.1 ISRO Telemetry, Tracking and Command and (ISTRAC) is entrusted with the primary responsibility to provide spacecraft TTC and mission control services to major launch vehicle and Spacecraft missions of ISRO. Major objectives that go with the above key responsibility are carrying out mission operations for all operational remote sensing and scientific satellites, providing TTC services from launch vehicle lift-off till injection of satellite into orbit and to estimate its preliminary orbit in space and hardware and software developmental activities that enhance the capabilities of ISTRAC for providing flawless TTC and Space Operations services.

27.2 In order to realize these objectives, ISTRAC has established a network of ground stations at Bangalore, Lucknow, Mauritius, Sriharikota, Port Blair, Thiruvananthapuram, Brunei and Biak-1 & 2 (Indonesia) and the Deep Space Network Stations at Byalalu near Bangalore. The Mission Operations Complex located at Bangalore carries out round-the-clock mission operations for all remote sensing and science satellites. All network stations of ISTRAC are connected to the Mission Operations Complex (MOX) through dedicated high performance satellite/terrestrial communication links. Alternate Spacecraft Control Centres (ASCCs) established at Lucknow and ISDN provide the capability to switchover spacecraft operations from one location to another, in case of disaster scenarios affecting operations from MOX.

27.3 ISTRAC has also been mandated to provide space operations support for Deep Missions of ISRO, undertake development of radar systems for launch vehicle tracking and metrological applications, to provide

Search & Rescue and Disaster Management Services and maintenance of hub station for 'spacenet' services. Establishment, operation and maintenance of ground segment for the Indian Regional navigational satellite System consisting of IRNSS Navigational Control Centre connected to IRNSS CDMA Ranging/IRNSS Range Integrity Monitoring Stations through dedicated IRNSS Data Communication Network is yet another major responsibility vested in ISTRAC.

#### 27.4 Major Achievements during 2013-2014

- Provided pre-launch simulation, launch and early operations phase support for PSLV C20/SARAL and PSLV C22/IRNSS-1A. Biak-2 C/S-Band TTC station provided LEOP support for IRNSS-1A, INSAT-3D and GSAT-7 missions;
- Regular operation and maintenance of TTC Network stations at SHAR, Bangalore, Lucknow, Thiruvananthapuram, Port Blair, Brunei, Biak and Mauritius. In addition to these ISTRAC maintains two deep space network terminals viz., DSN-18 & DSN-32 operating in S/X band and a trailer mounted 4.6 m terminal operating in S Band;
- Provided round-the-clock operations support and payload programming for IRS satellites viz., IRS P6, CARTOSAT-1, CARTOSAT-2, Cartosat-2A, RISAT-2, Oceansat-2, CARTOSAT-2B, Hamsat-1, RESOURCESAT-2, MEGHA-TROPIQUES, RISAT-1 and SARAL;
- Displayed a 3metre *Receive Only* Terminal in Brunei for overcoming the line-of-sight obstruction for GSLV D05 flight over 10 m TTC Terminal due to the high rise building in the vicinity;
- Time chartered two Offshore Support Vessels for deployment of ISRO's Transportable TTC Terminals in the South Pacific Ocean for supporting Mars Orbiter Mission;
- Integrated, tested and commissioned transportable terminals onboard two offshore support vessels for use during launch phase of the PSLV C25/Mars Orbiter Mission;
- Entered into agreements with Kongsberg Satellite Company AS (KSAT), Norway, South African National Space Agency (SANSA) and FUNCATE, Brazil for regular and one-time support requirements of ISRO's Launch Vehicle and Spacecraft missions;
- Technical interfaces worked out with NASA/JPL, SANSA and INPE for Launch and Early Orbit support for Mars Orbiter Mission;
- Established the third Indian Uplink Station (INLUS-3) in New Delhi under GPS Aided Geo Augmented Navigation (GAGAN) –Flight Operations Phase. Development of DO-178B compliant Monitoring and Control Software is in advanced stage; Successfully realized Phase-1 of IRNSS Ground Segment (ISTRAC Elements) Implementation Plan. As part of this plan, ISRO Navigation Centre (INC), four CDMA Stations (IRCDR), IRNSS Network Timing (IRNWT) and eight IRNSS Range & Integrity Monitoring Stations (IRIMS) have been commissioned. ISRO Navigation Centre was inaugurated on 28<sup>th</sup> May 2013;

- Realization of baseband electronics for two transportable terminals;
- Action initiated for obtaining regulatory clearances from WPC for all RF installations (tracking and communications terminals) in India;
- Organized emergency payload operations over the flood hit areas of Jharkhand during June 2013 in order to provide imageries to the National Disaster Management Authority for monitoring the situation;
- Maintained ISO 9001:2008 Quality Management System for all technical entities of ISTRAC.

## **27.5 Major Programmes for 2014-2015**

- Continuation of round-the-clock operations support and payload programming for IRS satellites viz., IRS P6, CARTOSAT-1, CARTOSAT-2, Cartosat-2A, RISAT-2, Oceansat-2, CARTOSAT-2B, RESOURCESAT-2, YOUTHSAT-01, MEGHA-TROPIQUES, RISAT-1 and SARAL;
- Orbit insertion operations on Mars Orbiter and commencement of MOM Normal Phase Operations support;
- Operation and maintenance of TTC network stations at Bangalore, Sriharikota, Lucknow, Thiruvananthapuram, Port Blair, Brunei, Biak and Mauritius;
- Realization of the second 4.6m Transportable Terminal.; Operation and Maintenance of IRNSS Ground Segment consisting of ISRO Navigation Centre (INC), four CDMA Stations (IRCDR), IRNSS Network Timing (IRNWT) and Eight IRNSS Range & Integrity Monitoring Stations (IRIMS);
- Commencement of civil works and procurement action for the establishment of second ISRO Navigation Centre (INC-2) at Lucknow;
- Realization of critical systems like High-end Frequency Down converter, Delta Doppler One-way Ranging Receiver for Mars Orbiter normal phase support;
- Implementation of administrative workflow process modules under inter-centre Digital Work Flow System (DWFS);
- Continuation of quality improvement efforts through ISO-9001: 2008 quality management system at ISTRAC;
- Operation and maintenance of Space Communication Hub services for Spacenet, Tele-medicine, Edusat and VRC;
- Continuation of activities towards establishment of Phase-2 of the ground segment under Indian Regional Navigational Satellite System (IRNSS);

- Continued support to Disaster Management Charter and Search & Rescue Operations;
- Implementation of green cover and rain water harvesting plan for IDSIN, Bhalalu.

## 28. Space Applications Centre (SAC)

(₹ in crores)

<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
336.08	306.00	426.03

28.1 The main activities of the Space Applications Centre at Ahmedabad include Research and Development work in various areas of space applications which are primarily aimed at national development and development of payloads for remote sensing and communication satellites. The activities of the Centre are grouped under microwave systems, satellite communication applications, sensor developments, image & information processing and remote sensing applications. The Centre has facilities for mechanical and electronic systems fabrication. The facilities of this Centre include the Ahmedabad Earth Station, Delhi Earth Station, portable and mobile Earth Stations, Laboratories for remote sensing & communication activities, fabrication and environmental test facilities for development & qualification of space and ground hardware. The Centre is responsible for the development, realization and qualification of communication, navigation, earth observation and meteorological payloads & related data processing & ground systems in the areas of communication, broadcasting, earth observations for remote sensing of natural resources, weather and environmental studies, disaster, monitoring/mitigation etc. SAC has also been involving industry and practicing outsourcing & indigenous development of technology and vendors.

## 28.2 Major Achievements during 2013-2014

- Completed In Orbit Testing of IRNSS-1A Payloads and in orbit testing for INSAT-3D and GSAT-7;
- Pre-Launch Test of GSAT-14 Payload has been carried out at Launch Base, SDSC, SHAR;
- Spacecraft level integration & Testing of GSAT-6 and IRNSS-1B would be over by December 2013;
- GSAT-16 payload delivery to Project would be done by December 2013;
- Three payloads for Mars Orbiter Mission viz., Methane Sensor for Mars, Mars Colour Camera and Thermal Infrared Imaging Spectrometer were delivered to project during April-June 2013. All the three payloads have been integrated with spacecraft and autonomous tests are completed;
- Engineering Development Model of Crew Cabin Lighting System and Cabin Crew Environmental Monitoring System payloads for HSP were delivered to VSSC in April 2013.
- INSAT-3D Data reception and IMDPS software were enabled at IMD, New Delhi as well as Bopal mirror site at SAC;



- For MARS (MCC/TIS/MSM/LAP) data products software was designed and developed. Also a payload operations centre (POC) was established at SAC;
- Towards application development for FASAL, RISAT-1 data ingestion to FASALSOFT software was completed for the analysis of crop assessment;
- Computed Glacier mass balance for 2011 for 10 basins covering 800 glaciers;
- Mars Science Program Document was prepared highlighting major thrust areas to be initiated using Indian Mars Orbiter data along with other International Missions.
- GSAT-9 payload delivery to Project would be done by February 2014;
- Under Infrastructure-Facility Development & Mission Operations Support, sample preparation & process qualification are to be completed by March 2014, using Low temperature co-fire ceramic (LTCC) multilayer RF circuits, multi-chip module (a Technology development).

### **28.3 Major programmes for 2014-2015**

- Planned to complete the development and delivery of payloads for GSAT-11, GSAT-7A, INSAT-3DR, GSAT-15, GSAT-17, IRNSS-1D and IRNSS-1E;
- Sub-System level development is planned to be completed for GSAT-18, GSAT-19, GSAT-20, GISAT Tx, IRNSS-1F and IRNSS-1G;
- Development of receivers for IRNSS will be completed and IRNSS Signal Monitoring Facility will be established;
- Development of various Subsystems for GSAT-7A, GSAT-11, GSAT-15, GSAT-17, GSAT-18 & GISAT are in progress;
- Planned to complete BBM & EM for Aditya-1, LISS-4 & AWIFS A&B payloads for Resourcesat-2A, development, T&E and delivery of Cartosat-2C/D payloads to Project and Delivery of INSAT-3DR Sounder and INSAT-3DS Imager to the project;
- New and Repeat project activities will be taken up for MW payloads viz. Ka-Band Altimeter & Signal Processor for Chandrayaan-2 Lander, RISAT-1A, Oceansat-3 Scatterometer, X-Band space-borne SAR (RISAT-2A) and for NI-SAR;
- Planned to establish Close Range Photogrammetric facility for CHANDRAYAAN-2 Rover/ Lander data simulation and processing for real/near real-time applications;
- Simulation and modeling will be carried pertaining to GISAT and Oceansat-3;
- Global high resolution DEM will be generated, and Planetary Simulation & Immersive Visualization (PLASIV) lab will be established.



- The projects under RISAT Utilisation programme will be concluded, use of INSAT-3D data and products will be demonstrated for various applications and projects on SARAL Sciences and Applications and Meteorology & Oceanography Programme-III will be executed.

## 29. Development and Educational Communication Unit (DECU)

(₹ in crores)

<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
46.75	19.28	40.80

29.1 The Development and Educational Communication Unit (DECU) at Ahmedabad is involved in the conceptualisation, definition, planning, implementation and socio-economic evaluation of developmental space applications. The major current activities of DECU include EDUSAT projects, their implementation action & utilisation, Training and Development Communication Channel (TDCC), Village Resource Centre (VRC), Gramsat Programme (GP), Tele-Health (TH), Tele-Education (TE) mission and new satellite communication development and applications.

## 29.2 Major Achievements during 2013-2014

- Introduced CME facility in TM networks & a Learning Management System (LMS) server installed at ISTRAC TM hub, Bangalore, to accommodate 150 institutions/nodes;
- Around 100 nodes migrated from INSAT-3A to GSAT-12;
- TM network of Madhya Pradesh inaugurated on October 2, 2013;
- All 15 terminals of Chhattisgarh repaired and made operational;
- Resolved problems and operationalised some of the remote nodes on case-by-case basis and shifted some non-performing TM nodes;
- Contract awarded for CAMC of 100 TM nodes installed all over the country;
- TM Users' Meet of North-Eastern users held at Shillong with an aim to increase the utilisation of TM networks and TM Users' Meet planned at Jammu & Kashmir;
- ISTRAC TM hub to be optimised in order to increase the number of simultaneous consultations;
- Ext. C-band networks of Integrated Disease Surveillance Project was partially migrated from GSAT-3 to GSAT-12 and the Ku-band networks of Pudhucherry, WBUTU (partially) & Nagaland hub were also transferred from GSAT-3 to INSAT-4CR;
- Memorandum of Understanding (MoU) between Govt. of Rajasthan and ISRO 'EXTENDED FOR 2 MORE YEARS' under which Operations & Maintenance support to be provided to Rajasthan EDUSAT networks on a continuous basis;

- It is being decided that responsibility of TE programme for North-Eastern (NE) states will be handed over to NE-SAC under which technical support is being provided to NE-SAC for Comprehensive AMC, hub operation and establishment of Technical and Training Centre (TSTC) for all NE states;
- Successfully conducted a National TE Users' Meet at DECU/SAC Ahmedabad. 71 participants from 56 networks and 8 vendors participated;
- Ext. C-band EDUSAT networks of INDO-US & NCSM will be migrated from GSAT-3 to GSAT-12;
- 100 ROTs to be converted to interactive ROTs using GSM technology in West Bengal;
- A new Ku-band hub to be procured for Mizoram in place of the burnt hub and teaching-end;
- 14 video programmes produced - 6 related to EDUSAT & 8 related to ISRO Space Missions & special events, 42 more planned, initiated programmes based on Remote Sensing applications;
- 2 content generation trainings imparted - SATCOM Centre, Rajasthan, and MPAA, Bhopal. 1 training to Sikkim planned;
- 9 studies completed (4 related to TE & 5 related to SATCOM applications), activities related to 'Mapping Information and Communication Practices for Backward Regions of India' going on, detailed feedback study on ViCTERS EDUSAT network planned;
- Around 100 video programmes digitised, video quality assessment tool configured for quality assessment of digital files, a multi-function printer cum scanner cum copier procured and commissioned;
- Provided technical consultancy/support to Information Department, BISAG (Gandhinagar), ANSSIRD (Mysore), Rajasthan EDUSAT user's network, etc;
- Various equipments for HD programmes production setup are being procured and Non-Linear Editing (NLE) systems are being augmented to enable HD quality video editing;
- Motion Capture System to be installed and operationalised in the near future and licenses of Adobe Creation suite & Autodesk to be upgraded;

### **29.3 Major Activities Planned during 2014-2015**

- New TM nodes & mobile vans to be established as per the user requirement and the ISRO policy;
- AMC of GSAT-12 hub and provide technical support for conducting CME regularly;
- Assessment of the performance/utilisation of TM nodes and shifting of non-performing nodes in order to accommodate new users;
- National TM Users' Meet is planned;

- Upon obtaining clearances from ISRO HQ, it is planned to establish new TE networks in Uttar Pradesh and Himachal Pradesh as per the ISRO policy
- 100 ROTs with interactivity using GSM technology to be added to Madhya Pradesh TE network;
- As case study, at least 1 ROT channel of TE network to be upgraded to support High Definition (HD) transmission;
- Maharashtra, Rajasthan, RCI and ANSSIRD TE networks to be migrated to GSAT-12;
- Subsequent to the allotment of dedicated bandwidth, TE networks of Tripura, Meghalaya, Nagaland, Mizoram, Uttarakhand & GNDU to be migrated to new frequency and allotted bandwidth;
- 57 video programme production is planned - 12 for TE, 40 related to ISRO Space Missions & special events and 5 special programmes for Disaster Management;
- 3 content generation trainings planned;
- EDUSAT Evaluation Study at National level' to be completed, feedback studies for YCMOU/ West Bengal and ORSAC/Punjab are planned and 4 studies related to SATCOM applications will be completed;
- Procurement of 3D Production setup is planned for 3D video content creation;
- Central Storage System & Digital Asset Management System to be augmented for long term archiving of video programmes;
- High performance storage system to be established to facilitate collaborative working and content reuse;

### 30. National Remote Sensing Centre (NRSC)

(₹ in crores)

<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
199.00	192.51	244.09

30.1 NRSC is one of the Centres of Indian Space Research Organisation, striving to realize the Indian space vision, as a key player in Earth Observation and Disaster Management Support Programmes. NRSC is responsible for acquisition, processing and dissemination of aeriels and satellite remote sensing data and is continuously exploring the practical uses of remote sensing technology for multilevel (global to local) applications. It also has a focused programme of creating training manpower through capacity building in remote sensing. IIRS which was a constituent of NRSC became a separate Unit of ISRO in April 2011. RRSC (East) was shifted from Kharagpur to Kolkata in May 2011. RRSC (North) was merged with IIRS in October 2011. Present infrastructure of NRSC is spread over six campuses – Balanagar (Hyderabad), Bengaluru, Nagpur, Jodhpur and Kolkata.

## 30.2 Major Achievements during 2013-2014

- Upgraded services from the Antarctica Ground station for Earth Observation Satellites (AGEOS) with a high bandwidth network connection between Bharati station (Antarctica) and IMGEOS. Data acquisition needs of all ongoing & future IRS missions will be augmented through AGEOS facility. The AGEOS station enables India to acquire and provide global remote sensing data to the users;
- Data acquisition and processing operations from both Cartosat-1 & Cartosat-2 satellites were integrated into IMGEOS. A Product Failure Analysis Facility was established under IMGEOS;
- Establishment of the communication link between EUMETSAT, Darmstadt (Germany) and NRSC, Shadnagar (India) enabled NRSC the capability to acquire oceanographic and atmospheric data from SARAL satellite (launched on Feb 25, 2013) in Near Real Time (NRT), process it quickly to generate Operational Geophysical Data Records (OGDR) and transfer them (within 120 min from the data acquisition) in turn to MOSDAC (SAC, Ahmedabad) for further use;
- Significant developments under BHUVAN include releasing of Bhuvan Panchayat v1.0, content enhancement (both image and thematic layers), continuous disaster support during Uttarakhand flash floods and online geo-processing etc. Bhuvan portal is also being enriched with high resolution images for major cities / towns. NOEDA NRSC Open data archive) new version is also planned to be released;
- About 89,000 satellite data products are targeted for dissemination during the year besides free downloads through Bhuvan & Oceansat-2 Web portals. Geophysical data products services were improved by augmenting with chlorophyll products. User Interaction Meet is planned to be held during the first quarter of 2014;
- To continue to provide Information support in near real-time for disaster management on floods, cyclones, forest fires, and landslides and in-season forecast on agricultural drought under DSC;
- Carried out damage assessment on various floods/cyclone events in 15 States during 2013 flood season and about 109 maps showing inundation and damage to infrastructure were furnished to the User. These include the Uttarakhand flash floods leading to landslides and debris flow and also the Cyclone Phailin;
- NADAMS Analysis Software (NAS) Version 1.0 is being operationally used by MNCFC for drought assessment. In 2013 fire season, 23,636 fire alerts were operationally communicated to user within 60 min of data reception (with >90% accuracy). As part of Sentinel Asia, support is being extended on request basis. The major computer infrastructure for NDEM is being procured during current financial year;

- As part of Natural Resources Census (NRC), 9th cycle (2012-13) of Land Use / Land Cover (LULC) assessment (1:250,000 scale) was completed and 10th cycle (2013-14) was initiated. 2nd cycle of the National LULC mapping (1:50,000 scale) and the Nationwide geomorphological and lineament mapping (1:50,000 scale) are in progress and expected to be completed by March' 2014;
- Under Major User funded Projects, the Rajiv Gandhi National Drinking Water Mission (Phase-IV) and NWDPRA watershed monitoring (Phase III), Glacial lakes and water bodies monitoring, seasonal snow melt runoff in Chenab, Beas, Sutlej, Yamuna and Ganga river basins projects are in progress. The India-WRIS project is also planned to be completed during the year;
- Towards Atmospheric and Climate studies, six atmospheric CO<sub>2</sub> monitoring stations were established to study the changes with respect to environmental factors and biospheric responses. Towards assessing the Carbon Pools, Fluxes and Net Carbon balance for terrestrial biomes in India, a set of three inter-related sub-projects are being executed under the National Carbon Project (NCP). Besides, another four themes are also being pursued under NCP to understand the ocean-atmosphere carbon fluxes as part of the 12th Five year Plan activities.;
- Under Aerial Services and Digital Mapping activities, both aircrafts were flown for about 163 hours (till Sep' 2013) for aerial photography tasks for I-GBP (RAWEX & NCP) and EOAM (J&K) projects. Planned surveys include LiDAR data acquisition for DMSP & IGBP, hyperspectral data acquisition (EOAM) and operationalisation of the flight model of DM-SAR sensor. Phase-III of the GCPL project is initiated;
- Regular, customized and special training courses on geospatial technologies are being organized including in-house programmes on topics like RS&GIS, Geoinformatics, Airborne LiDAR Applications etc as part of the Training & capacity building. So far 10 programmes were organized including four Special (microwave-2, women-1 & private entrepreneurs-1), three Customized (NCRPB and DIPAC), two Regular and one In-house STP training 214 persons. Besides another four courses including three Customised and one Special course are planned during the year;
- Major infrastructure augmentation planned include procuring new aerial Large Format Digital Camera and Fourier Transform Infra Red Spectroscopy, upgradation of security infrastructure, modernization of computer infrastructure of Regional Centres, improving the new NDEM facility with required software and hardware, distributed architecture set-up for Bhuvan services, Virtualization system for IMGEOS.

### **30.3 Major Programmes for 2014-2015**

- Planned to integrate all ongoing and future IRS missions into IMGEOS;
- IRS data acquisition shall be operationalised from AGEOS Facility;
- In Bhuvan, besides others, major improvements planned for next year include – operational Bhuvan distributed services from the Regional Centres, increasing the role of Crowd sourcing for Point of Interest data and updataion in Bhuvan Panchayat services;

- Under DMSP, it is planned to continue to support all services and development works for various natural disasters. Besides, Flood Hazard Atlas for Orissa will be initiated and flood forecasting and inundation modeling will be carried out for Godavari river. Work on Urban Flood modeling for part of Hyderabad City will be initiated;
- All DOS Funded Programmes like NNRMS, ISRO-GBP, EOA, NICES, TDP and Utilisation Programmes and all ongoing User funded National Missions and Projects like RGNDWM (Phase – IV) (to be closed in 2014-15), seasonal snow melt run-off and ocean and atmospheric studies shall be continued and research initiatives under various programmes shall be pursued;
- Future AS&DM activities / services include augmentation of the aerial sensors (ALS-70, atmospheric sensor, infrared and hyperspectral instruments), LiDAR data acquisition and processing for Assam (15,000 sqkm), East coast (Paradeep to Sunderbans) and Aerial photography over 16 coal mines;
- The Training Division would be organizing Custom and Special courses besides the Regular courses In-House and STP courses will be carried out like last year. Special emphasis and attention would be given to courses for Private/ Industry, Women and Hyperspectral remote sensing;
- Major Infrastructure Augmentations includes – Procuring Atmospheric sensors, unified storage (NAS/SAN) for archiving aerial data, upgrading the avionics of one Aircraft, Augmentation of Airport Hanger with state of art instrumentation facility;

### 31. Indian Institute of Remote Sensing (IIRS)

(₹ in crores)

Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
30.35	25.94	40.55

31.1 The Indian Institute of Remote Sensing (IIRS) located at Dehradun is responsible for capacity building in the field of Remote Sensing and GIS applications. It has grown manifold and has established itself as an institute of repute both nationally and internationally. Realizing the potential of Earth Observation System and ISRO's forthcoming initiatives in the areas of natural Resource Survey, Earth & Atmospheric Sciences & Oceanography, IIRS has been reorganized as a separate entity of ISRO w.e.f. April 30, 2011. IIRS will continue its training, education and research programmes with enhanced focus on Microwave Remote Sensing, Hyper-spectral Remote Sensing and Climate studies.

### 31.2 Major Achievements during 2013-2014

- Continue to conduct various scheduled courses (i.e. Certificate/ Diploma/M.Tech./M.Sc./ITEC/ NNRMS) as per Academic Calendar 2013-14 and Tailor made user defined courses;



- Planned to customise courses for capacity building of State/Central Govt. Departments Officials implementing various national level developmental programs /schemes;
- Planned to customise summer training for students of various Universities;
- Strengthening of IIRS training activities with close interaction with the State Department and National Institutions;
- Support to CSSTEAP for conducting RS & GIS course and other short programs;
- Plan to continue TDP in emerging areas of Remote Sensing, spatial modeling and instrumentation and collaborative R & D activities with other DOS/ISRO Centres;
- Collaborative research with major National Institutes i.e., WIHG, SASE, NIH, GB Pant Institute, Y.S. Parmar University under EOAM Research programme on 'Monitoring & Assessment of Mountain Ecosystem in Western Himalayas';
- Procurement of Spectro-radiometer with accessories for Hyperspectral lab (2,400 nm to 16,000 nm), Full Bistatic Ground Penetrating Radar (GPR), Terrestrial Laser Scanner (TLS), Portable Laser Scanner, Spectro sensor for continuous NDVI & PRI measurement, Wet Sieving Apparatus, Soil Permeability Meter, Direct Shear testing equipment, Microtop II Sunphotometer;
- Augmentation of Central Data Center Networking & Server Upgrades and Main Server;
- Upgradation of MAT Lab software, Flood Modelling Software, SARSCAPE Software, TNT MIPS v2012 software, PCI Geometica software, River Tools software licenses, City Engine software;
- Replacement/Augmentation of PC's/workstations of various IIRS Labs, augmentation of ACS and Video surveillance and replacement of EPABX system Video & Tele-conferencing facility;
- Replacement of DX type AC plan with Room AC unit, procurement of 500 KVA automatic voltage stabilizer, 150 KVA UPS system, Incinerator and providing new street lighting in the campus;
- In the aftermath of devastating floods & landslides in Uttarakhand in June, IIRS in association with ISRO Hqs, SAC, Ahmedabad and NRSC, Hyderabad provided possible support to the State on priority.

### **31.3 Major Achievements during 2014-2015**

- Planned to continue to conduct various scheduled courses (i.e. Certificate/ Diploma/M.Tech./M. Sc./ITEC/NNRMS) as per Academic Calendar 2014-15 and Tailor made user defined courses;
- Planned to customise courses for capacity building of State/Central Govt. Departments Officials implementing various national level developmental programs/schemes;

- Planned to support summer training for students of various Universities/Institutes;
- Strengthening of IIRS training activities with close interaction with the State Department and National Institutions;
- Support to CSSTEAP for conducting RS & GIS course and other short programs;
- Plan to continue TDP in emerging areas of Remote Sensing, spatial modeling and instrumentation and collaborative R & D activities with other DOS/ISRO Centres;
- Collaborative focused interdisciplinary research with major National Institutes i.e., WIHG, SASE, NIH, GB Pant Institute, Y.S. Parmar University under EOAM Research Programme on 'Monitoring & Assessment of Mountain Ecosystem in Western Himalayas';
- Gamma Software with Add-on modules, EOAM-Equipment & Software for application Project, IP Earth Resistivity Meter, Hydrological modeling software including full Suit Mike models and visual Mud Flow, Digital Water Level Recorder Pressure based with telemetry, Automatic weather sensor with data logger and telemetry, SWE measuring, snow scale instruments with data logger, Snow precipitation gauges with data logger and telemetry, Central Data Centre Networking and Server Upgrades and Centralized Storage and Computing Facility, Mobile GIS, Upgradation of Photogrammetric software LPS with terrain editor;
- ACS and Video Surveillance Augmentation, replacement of 30 year old panels and providing street lighting on new road/pathways;
- Planned to replace old technical furniture, procure new furniture for various departments, hostels & EDUSAT studio, furnishing of new rooms in guest house and passenger lift for main building;
- Planned to procure Video Conferencing System for CSSTEAP, providing work-stations and storage in SDDTEAP Hqs., automaion of pump house, DG sets, Sub-stations ad AC Plants with SCADA System, Storage solutions for Record rooms & instruments;
- Planned to replace faulty and old power cables, 110 KVA DG set with 20KVA set and associated works, replace old AMF Controllers in 2 DG Sets and old HT Oil Circuit Breakers with new 3 Breaker VCB Panel;
- Proposed vertical extension of GID Building, 60 KVA Solar Plant balance work and new work on Slope Protection Works on NE Slopes and Land reclamation, Commencement of the Golden Jubilee Works like construction of golden jubilee hostel block, security gate complex & car parking, face lifting of main building, additional rooms in guest house & upliftment of campus entrance and parts of Master Plan Works.



## 32. Master Control Facility (MCF)

(₹ in crores)

<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
73.91	56.25	84.07

32.1 The Master Control Facility (MCF) located at Hassan in Karnataka is responsible for initial orbit raising, payload testing and in-orbit operation of all geostationary satellites. MCF has integrated facilities comprising satellite control earth stations with associated electronics. The Satellite Control Centre (SCC) is the nerve centre for satellite control operations. A back-up MCF (MCF-B) at Bhopal, Madhya Pradesh with essential facilities to manage the satellite operations has been commissioned.

### 32.2 Major Achievements during 2013-2014

- LEOP operations of IRNSS-1A Mission successfully completed;
- In-Orbit Tests on IRNSS 1A completed as per plan;
- LEOP operations of INSAT-3D Mission successfully completed;
- INSAT- 3D In-Orbit Tests - Phase#1 completed in August 2013, and Phase #2 completed after 'Flip' operations during September 2013;
- LEOP operations of GSAT-7 Mission & In-Orbit Tests on GSAT-7 completed successfully and Satellite declared operational for Users in September 2013;
- Satellite Control Earth Station #9 (SCES#9) under IRNSS Project commissioned and deployed for regular operations;
- Civil Construction works of additional quarters for CISF Staff at Hassan started;
- Planned to complete LEOP operations and In-Orbit tests of GSAT-14 Mission;
- Planned to operationalise SCES #2 at MCF-Bhopal campus;
- Planned to augment Automated Test Equipment (ATE) Set-up for In-Orbit Tests (2<sup>nd</sup> phase) at SCES #4 by October 2013;
- Planned to complete civil construction works of Optical Telescope Project at Mt. Abu by January 2014 (Civil works being executed by CMG-PRL);
- Civil Construction works of additional staff quarters at Hassan nearing completion. Allotment scheduled during November 2013.
- Planned to complete construction works of IRNSS Satellite Control Centre (at Hassan);
- Planned to introduce Biometric based Access Control System.

### 32.3 Major Activities Planned during 2014-2015

- Planned to complete LEOP operations of IRNSS – 1B & 1C Missions;
- Planned to complete LEOP operations of GSAT-16 & GSAT – 6 Missions;
- Planned to commission IRNSS Satellite Control Centre in new land;
- Planned to establish C band Earth Station with an 11m, 'high-speed' FMA Terminal for GEOSAT programmes;
- Planned to establish C / S band Earth Station in the Western Hemisphere;

### 33. National Natural Resources Management System (NNRMS)

(₹ in crores)

Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
31.50	18.00	30.30

33.1 The National Natural Resources Management System (NNRMS) has the objective of ensuring optimal management/utilisation of natural resources by integrating information derived from remote sensing data with conventional techniques. The NNRMS umbrella includes a large cross-section of Government Departments/Agencies, which are responsible for resources management sectorally and other agencies associated in developmental activities. NNRMS activities are co-ordinated at the National level by the Planning Committee of NNRMS (PC-NNRMS) which frames guidelines for implementation of the systems and oversees the progress of remote sensing applications for natural resources management in the country. Nine Standing Committees are (i) Agriculture & Soils (ii) Bio-resources (iii) Geology & Minerals (iv) Water resources (v) Rural Development (vi) Urban Development (vii) Cartography (viii) Ocean & Meteorology and (ix) Training & Technology. NNRMS, thus, encompasses conceptualisation and implementation of space system with ground-based data reception, processing and interpretation systems and integrating the satellite-based remotely-sensed data with conventional data for resource management applications in various thematic areas.

33.2 Considering the changing technological and applications dimensions in the country and elsewhere, the NNRMS currently focuses on (i) user funded projects meeting the objectives/goals of the user Departments/Agencies both at the national and regional/local scale; (ii) proactive applications projects of relevance at the national and regional/local scale and (iii) organising the spatial databases for supporting, planning, implementation and monitoring of a variety of developmental programs.

### 33.3 Major Activities during 2013-2014

- Space based information System for Decentralised Planning (SIS-DP) project taken up at the behest of PC-NNRMS aims to develop ICT enabled geospatial platform using space based

EO systems and engage local bodies for planning and execution of area based developmental activities in a decentralized, speedy and transparent manner. The scale of mapping while creating thematic geo-spatial database is at 1:10,000 scale. The resource information which are being prepared are mainly from four different sources (1) High resolution satellite images, (2) Village Cadastral maps, (3) User departments data, (4) Existing resource GIS layers / databases generated by central/state centres. All the thematic layers will be created on 1:10,000 scale using ortho-rectified high resolution satellite images (Cartosat+LISS4 MX fused). Digital Village cadastral maps are being overlaid onto Ortho-rectified imagery for the five priority states (Kerala, Haryana, Andhra Pradesh, Assam and West Bengal). For the first time, the orthorectified satellite data preparation from Cartosat-1 and LISS IV has been generated for the whole country. Mapping for the land cover and infrastructure layers at 1:10,000 scale has been completed for 35000 sheets. Integration of the legacy databases was completed for 21 of the 35 states/UTs. Overlay of cadastre maps was completed for 10,000 villages and training on decentralized planning was imparted to about 1100 line department officers. The Bhuvan Panchayat portal (version 1.0) is released for operational use;

- Under Natural Resources Census project, Mapping for the 9<sup>th</sup> cycle of Land use/Land Cover mapping at 1:250,000 scale (2012-13) has been completed and statistics were derived. The net sown area was estimated at 148.2 Mha in 9<sup>th</sup> cycle as against 153.20 Mha in 8<sup>th</sup> cycle (2011-12). The LULC data of previous 8 cycles has been hosted on Bhuvan web portal. Activities have been initiated for 10<sup>th</sup> cycle mapping;
- Subsequent to the successful completion of the 1<sup>st</sup> cycle of Land use/Land cover Mapping at 1:50,000 scale, the 2<sup>nd</sup> cycle of land use/land cover has been taken up towards generation of seamless spatial database as well as land use/land cover changes with respect to 1<sup>st</sup> cycle database. The project is nearing completion. Data interpretation has been completed for 501 out of 597 districts in the country;
- Geomorphological and lineament mapping has been completed for 4,560 out of 5,580 maps of the entire country;
- Forest cover change alert system using IRS multi sensor data project has been taken up to develop semi automated forest cover change detection methodology using multi temporal data. Under the pilot study, forest cover change alerts were provided for parts of Jalgaon and Gadchiroli Districts (Maharashtra). Analysis for 6 states (Andhra Pradesh, Chattisgarh, Himachal Pradesh, Maharashtra, Madhya Pradesh and Karnataka) is in progress;
- Under the Natural Resources Database project, the repository has been populated with additional geospatial database including the ongoing projects like Natural Resources Census, Rajiv Gandhi National Drinking Water Mission etc. NRDB has altogether 1353 layers in which 128 layers added recently from NUIS, wetland and NRC projects. NRDB has registered users from India around 2114 and there are 23 foreign users. Creation and uploading of NRDB metadata on NSDI server (425 layers covering 14 states completed) has been also done;

- GCPL Phase-III project has been initiated and it is planned to densify the Ground Control Points (GCP) for satellite data calibration;
- Extended technical and financial support to various agencies/institutes for conducting multitier/ multi-theme training courses. Efforts of satellite based distance learning programme in RS&GIS is being continued to cover more number of Universities/academic institutes;
- Technical support is provided to State Remote Sensing Applications Centres for executing projects of relevance to development of the States.

### **33.4 Major activities planned during 2014-2015**

- Under SIS-DP project, preparation of natural resources mapping at 1:10,000 scale for another 27,000 sheets of the country will be completed and will be systematically organized for dissemination. In addition, cadastral overlay for 5 priority states will be completed. Dissemination of information/data will be done through Bhuvan Panchayat Portal;
- Under NRC project, the 10<sup>th</sup> cycle of Land use/Land Cover mapping at 1:250,000 scale will be carried out and mapping activity for the 11<sup>th</sup> cycle will be initiated;
- The efforts of satellites data preparation and land use/land cover mapping under 2<sup>nd</sup> cycle of Land use/Land Cover mapping at 1:50,000 will be completed;
- The geomorphological and lineament mapping for the country will be completed and the data/information will be disseminated through Bhuvan portal;
- Forest cover change alert system using AWiFS data will be extended for the rest of the country;
- NRDB Repository would be updated with the datasets from the ongoing projects. Efforts towards development of WMS from on INTERNET and SCANET, Mobile access of NNRMS portal etc. will be carried out;
- Under GCPL Phase-III activities, it is planned to collect GCP for another 4000 points and 100 hours of aerial data acquisition using LFDC sensor;
- Considering the technological development and requirement a few new projects will be taken up in different application areas;
- Planned to continue efforts for providing technical support to State Remote Sensing Applications Centres as well as human resources development in the area of RS&GIS;
- Planned to continue user sponsored projects in different application areas at the behest of respective user Ministry/Department.

### 34. Disaster Management Support (DMS)

(₹ in crores)

<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
30.42	14.00	21.37

34.1 The Disaster Management Support (DMS) Programme of ISRO provides near real time support and services from aero-space systems, both imaging and communication, towards efficient management of disasters in the country. The DMS programme addresses the natural disaster such as flood, cyclone, drought, forest fire, landslide and Earthquake. The major components of the DMS programme include creation of digital database for facilitating hazard zonation, damage assessment, monitoring of major natural disasters using satellites and aerial data, development of appropriate techniques and tools for decision support establishing satellite based reliable communication network, deployment of emergency communication equipment and R&D towards early warning of disasters.

#### 34.2 Major activities and achievements during 2013-2014

- Regular monitoring of all flood events and the dissemination of information to the concerned. In 2013, 15 states have experienced flood disasters;
- Flood Hazard atlas prepared for Bihar using the data from 1998-2010;
- Detailed analysis has been carried out for Uttarkhand flash floods disaster and the information has been disseminated to the concerned;
- 12 Type-D terminals provided to Uttarkhand police for communication support during disaster. Five DMS VPN nodes installed in Uttarkhand to support disaster situation;
- Supporting Mahalanobis National Crop Forecast Centre (MNCFC), Ministry of Agriculture (GOI), for monthly drought reports of 13 states during the Khariff season;
- Near real time active forest fire alerts are being generated twice a day during the fire season (February to June). The information was disseminated to ~400 nodal officers of all State forest departments across the country through DSC-INFFRAS website and web-posting on BHUVAN;
- Data acquisition of Airborne LiDAR-DC for 12000 sq. km over Mahanadi basin and Brahmaputra basin, and data processing of already acquired data of Godavari and Mahanadi basin is planned;
- Conversion of 36 towns of Aerial 1:2000 data from CAD format to GIS compatible format is initiated. Conversion of Hyderabad CAD drawings 1:2 K (233 sheets) to Geodatabase along with Geotagging is completed;

- Initiated development of web application to facilitate NDEM Nodal Officers for uploading information on local system in both desktop and Mobile PDA/PhoneGap environment. Desktop application development is completed;
- NDEM services have been launched through the Virtual Private Network;
- To visualize the NDEM services, GIS based viewer with GIS functionalities are developed. The user can select the web map services and visualize the same;
- A Mobile based application is developed for locating and adding the attribute information of essential amenities and retrieval of information at the time of emergencies and will be implemented after T & E;
- High resolution satellite data over Indian towns and cities for NDEM projects is being acquired for 497 class-I towns;
- Supported Sentinel Asia and International Charter by providing IRS data during the year. 80 datasets from IRS satellites are provided in the year 2013;
- The customization of DTH based DDWS instruments completed with BEL Bangalore, 200 systems have been delivered and installation is in progress;
- Completed the installation of S-band DWR antenna and radome at Cherrapunji. Installation of electronic subsystems completed. Completion of all pending infrastructure works for DWR installation – civil, electrical and A/c works and commissioning is planned this year;
- The C-band DWR at TERLS Trivandrum, Factory Acceptance Testing (FAT) cleared for the full system except for the transmitter. Antenna and radome were installed at site-TERLS. All major civil works completed. A/C works completed. Completion of electrical works in progress;
- Completion of installation, testing and trial runs of the full DWR system and Commissioning of the system is planned.

### **34.3 Major activities planned during 2014-2015**

- Near Real Time Flood Mapping and Monitoring of all the floods in the country;
- Flood hazard atlas for Orissa will be released and for West Bengal action has been initiated;
- Studies on Flood Hazard and Risk assessment with LIDAR DTMs in collaboration with academic institutions and Flood Inundation Simulation Modeling;
- Responding to sensitive and strategic requests from MHA/MEA including Monitoring of Man-Made interventions/Structures over Trans-Boundary Rivers;
- Event based monitoring depending on major earthquakes and landslides for preparation of damage assessment maps;

- Data acquisition of Airborne LiDAR-DC for 11500 sq. km over Brahmaputra basin and Ganga basin (6500 sq. km of part of Assam Ph-II area and 5000 sq km of West Bengal area);
- Airborne LiDAR-DC data processing of already acquired 12000 sq. km over Mahanadi basin and Brahmaputra basin;
- Establishment of NDEM Mirror Server at MHA, New Delhi, Development of Decision Support Tools for NDEM. Deployment of NDEM services to various states through ISRO-VPN network (Zone-1, Zone-2);
- Integration and deployment of Phase-II systems will be carried out at NDEM, Shadnagar;
- Operation & Maintenance of MSS-Type-D hub and maintenance of Type-D terminals;
- To make C-band Airborne SAR system operationalised and X-band experimental flights to understand the very high resolution processing;
- Upgradation of MHA-VPN network. As the NDEM services are being provided through DMS-VPN extension to districts is becoming essential. Pursuing with MHA for extension of the network to district Emergency Operation centers of the 241 multi hazard prone districts of the country;
- Develop license free server GIS software for preparation of reference data for field work and integration of field collected data. Develop and integrate GIS modules for data browsing, query, classification, analysis and map as well report generation;
- Operationalisation of the Doppler Weather Radars at Cherrapunji and TERLS, Trivandrum.

### 35. ISRO Geosphere Biosphere Programme (ISRO GBP)

(₹ in crores)

Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
26.73	14.00	20.00

35.1 The ISRO GBP focuses its research efforts on understanding the natural rhythms and patterns of the Earth system's self regulation, the extent to which anthropogenic forcing interacts with the natural variability of Earth system in producing climate change, the types, scales and rates of change and the thresholds of changes that threaten sustainable development. The research is done through multi-institutional participation and co-ordinated effort. The programme generates the scientific knowledge for decision making and inputs to international protocols and conventions.

#### 35.2 Major Activities during 2013-14

- As part of Aerosol Climate Forcing project, successfully executed two aircraft campaigns during winter and pre-monsoon seasons across the Indian landmass under the aegis of Regional Aerosol Warming Experiment (RAWEX). Each campaign involved around 100 hrs of flying



of the aircraft fitted with isokinetic inlets and instruments for measuring the vertical profiles of aerosol optical depth and physical parameters;

- From the first-ever regional synthesis of more than two decades of primary data on aerosol obtained from the Aerosol Radiative Forcing (ARFINET) observatories, the long term increasing trend in spectral Aerosol Optical Depth (AOD) over the Indian region has been established and it is caused by the increasing abundance of anthropogenic sub-micron aerosols;
- Extensive measurements of the vertical structure of aerosol absorption under RAWEX have led to “self-lifting” hypothesis, by which black carbon particles could reach lower stratosphere with implications including the slowing down of stratospheric ozone recovery;
- Aerosol- cryosphere- atmosphere interactions is yet another first of its kind studies in India, to estimate the effect of aerosol deposited over snow and glaciers in the Himalayas on snow albedo forcing and consequence on aerosol atmosphere interaction, through a synergy of scouting expeditions, network data and modeling;
- A synthesis of the ultra-fine particle size distribution, measured over the oceanic region during Campaign for Aerosol gases and Radiation Budget (ICARB), with satellite derived chlorophyll data, has brought out the distinct roles of anthropogenic emissions and ocean-bio-chemistry in generation of ultra-fine particle and its role in the aerosol life cycle;
- Progress in the National Carbon Project activity includes estimation of the spatial phytomass density for 1995-2010 period for the national grid; and mapping of forest cover of Central India was completed (1935-1960-1975-1985-1995-2005-2010 period) under the Long term forest cover change mapping of Vegetation Carbon Pools & Dynamics;
- Under the Soil & Vegetation-Atmosphere Fluxes project two flux towers have been established at Betul in Madhya Pradesh & Sundarbans in West Bengal, for the continuous measurements of Green House Gases. Analysis of data show that Teak mixed deciduous forests of Betul are sink of CO<sub>2</sub> during leaf-on season relative to the leaf-off season, while mangroves showed more or less similar CO<sub>2</sub> sequestration patterns round the year;
- Under the project on nitrogen cycling, three short-term field campaigns have been undertaken, where experiments to measure nitrogen and carbon uptake rates along with N<sub>2</sub>-fixation rates using stable isotope techniques were performed in the Cochin estuary. Results show that nitrogen uptake rates at all locations within the estuary were very high compared to open ocean bloom conditions;
- As part of Paleo-monsoon reconstruction from Speleothems, high resolution oxygen and carbon stable isotope measurements for the two stalagmites, one from Belum cave, Andhra Pradesh and another from Kotumsar cave, Chhattisgarh were taken up and a major part of mass spectrometric measurements have been completed;
- Under Energy and Mass Exchange in Vegetative Systems project, techniques have been developed for Evapo Transpiration (ET) modeling within energy balance framework using optical-thermal data & for regional Gross Primary Productivity (GPP) using Light Use Efficiency (LUE) model and vegetation fraction from Geo satellites;



- As part of the studies on Land Use and Land Cover (LU/LC) Modeling & Impact of Human Dimensions in Indian River Basins, LU/LC datasets on 1:250,000 scale have been prepared at decadal interval (1985, 1995, 2005) for all the 14 river basins. Basin-wise datasets (physical and socio-economic) at decadal interval have been prepared for all the 14 river basins. An indigenous model using open source tools is developed for modelling LULC dynamics and it is tested and validated in a couple of river basins;
- IGBP has produced several scientific publications in peer-reviewed journals of international repute;

### 35.3 Major Activities Planned during 2014-2015

- In continuation to the completion of first level data analysis and consolidation of results from RAWEX aircraft experiment, high altitude balloon experiment for the measurement of vertical profiling of black carbon and vertical profiling of aerosols using LIDAR data in Port Blair, Bay of Bengal, would be taken up;
- As part of palaeo-monsoon reconstruction from Speleothems, radiocarbon dating and counting of laminations of the two stalagmites, Belum cave, Andhra Pradesh and another from Kotumsar cave, Chhattisgarh are planned;
- As part of Soil & Carbon Pool Assessment, statistical analysis of CO<sub>2</sub> emission observations and ; ground truth collection of data in AP, Karnataka, Kerala, HP, Uttarakhand, Rajasthan, MP during rainy season would be taken up;
- Planned to establish a new eddy flux tower at Kanha, Madhya Pradesh and also the upscaling of carbon flux tower data to regional scale using remote sensing;

## 36. ISRO Sponsored Research Programme (RESPOND)

(₹ in crores)

<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
22.80	12.00	21.72

36.1 The ISRO Sponsored Research Programme (RESPOND) supports research and developmental projects and other scientific activities at the academic institutions and R&D laboratories in the country in the areas relevant to the Space Programme. In addition, RESPOND also supports Advanced Technology Research in Space Technology Cells established at premiere Institutions like IIT's and IISc.

36.2 The main objective of this programme is to establish strong links with academic institutions in the country to carry out research and developmental projects which are of relevance to space and derive useful outputs of such R&D to support ISRO programmes. RESPOND programme aims to enhance academic base, generate human resources and infrastructure at the academic institutes to support the space programme. The major activity of RESPOND is to provide support to research projects in wide range of topics in space technology, space science and space applications to universities/ institutions. In addition conferences, workshops and publications, which are of relevance to space research, are also being supported.

36.3 During the year, 14 New Projects were initiated at 11 academic institutions and 31 Ongoing Projects have been approved for supporting. Space Technology Cells established at IIT, Kharagpur & Bombay and Joint Research Programme at University of Pune, and 37 conferences/symposia/ publication and other scientific promotional activities have also been approved for supporting and 14 RESPOND projects have been successfully completed.

Projects are being carried out at ISRO established Space Technology Cells at IISc, Bangalore; IIT Madras; IIT Bombay, IIT Kanpur, IIT, Kharagpur and Joint Research Programme at University of Pune.

### 37. Atmospheric Science Programme (ASP)

(₹ in crores)

Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
21.80	13.81	23.37

37.1 Atmospheric Science Programme (ASP) has been formed to provide an impetus to studies and research in the critical areas of atmospheric of modeling and a mechanism for interactions with Scientific Department and academia for initiating/taking up suitable projects, leading to operational end user products in different domains. The primary goal of Atmospheric Science Programme will be to adopt a holistic approach towards generation, validation and assimilation of data (ground based, oceanic, atmospheric, satellite, radar data) and develop tailored models with advanced land-ocean-atmosphere process, moisture fluxes, could dynamics for operational applications of socio-economic relevance.

### 38. Earth Observation Applications Mission (EOAM)

(₹ in crores)

Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
4.37	2.06	4.03

38.1 The thrust of EOAM is mainly (i) evolve newer applications. R&D Programmes based on technology trends - leading to operational applications programmes (ii) guiding remote sensing applications programme with the user community towards implementation of remote sensing based solution and (iii) steering commercial activities of remote sensing involving development of value added services. Under EOAM various R&D and technology development studies like horticultural inventory, fluvial geomorphological mapping, snow and glacier studies, precision farming, water use in agriculture, surface deformation/mapping using differential

SAR interferometry, desertification monitoring and assessment, geophysical investigations, etc. Apart from the above, pre-investigation studies of Cartosat are also being carried out. Some of the new remote sensing applications studies planned/taken up under EOAM include hot spot mapping and monitoring, coal pitheads, riverine wetlands, forest ecosystem, working plan for forest management, crop growth monitoring system, etc.

### **38.2 Major Activities Completed/Planned during 2013-2014**

- Completed seven projects out of twenty five ongoing projects using Optical, Hyperspectral, microwave remote sensing techniques; Some of the completed/ ongoing projects are as following:
  - Mapping the ecological condition of coral reefs of the world;
  - Snow and Glacier Studies: Phase-II;
  - Narcotic Crop Assessment Project (NCAP);
  - Soil Health Card for a selected micro watershed of Ri-Bhoi District of Meghalaya;
  - Above ground biomass estimation using SAR data in tropical and subtropical forests of North East India;
  - Water balance analysis of Umiam (Barapani) reservoir in Meghalaya;
  - Fire risk alarm system using integrated approach;
  - Experimentation on international crop assessment using EO data;
  - Integrated Spatial Farming Systems Analysis Techniques with RS and Ancillary data;
  - Land Cover Change Atlas;
  - Satellite based Thermal Data Utilization For Crop Condition Assessment;
  - Development of Satellite Radar Altimeter Waveform re-tracking algorithms for accurate height over land and inland water bodies;
  - Estimation of periodic water balance components and generation of geo-spatial hydrological products at uniform grid-wise at National scale;
  - Early Warning System for Flood Disaster Mitigation – Using Space Inputs through Hydrological Modelling Approach;
  - Flood Inundation Modelling for Urban & Riverine Catchments;

- GPS & GAGAN/IRNSS data analysis for Intra-Plate Geodynamic Profiling in Active Seismic Zones;
- Operational methodology for horticultural crop inventory;
- Monitoring of rice and maize growth and yield under variant nitrogen in soil by remote sensing technique;
- Remote Sensing based Hydro-Meteorological Data Assimilation in the Hydrological and Weather Forecasting Models;
- Mapping, Modeling and Impact Assessment of Land Subsidence in Northern India;

### **38.3 Major activities planned during 2014-2015**

- Creation of spectral library using airborne sensor ;
- Precise Terrain Parameter extraction using Low Altitude Platforms data;
- Remote sensing, ground observations and integrated modeling for flood early warning system of North West Himalayan region;
- Development of spectral library and reflectance spectroscopy for mineral exploration in parts of mineral rich belt of Rajasthan and Odisha;
- Evaluation of Pol-InSAR data for forest biophysical parameter retrieval;
- Optimizing parameters from multiple sensors for biomass estimation at ICESat GLAS footprint level using different regression algorithms;
- Synergistic utilization of earth observation data for Automatic Retrieval system and monitoring of water, vegetation and built up area at variable scales;

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## FINANCIAL REVIEW

1. The budget formulation process of the Department has been evolved over the years with emphasis on reviewing the resource requirements with reference to the criteria of Zero Base Budgeting approach. Multi-level budget reviews are carried out at the DOS/ISRO Centres/Units and Project Management Boards/ Management Councils consistent with the programmatic and financial guidelines of the Department. The essentiality of each item, the schedule-budget linkages and cash flow requirements are critically analysed while formulating the budget.

2. The Department has evolved a mechanism of reviewing and monitoring the commitment and expenditure status of various programmes/projects approved in the annual budget periodically and take appropriate action, for making financial management more effective. In order to have better expenditure management, the monthly cash flow is also monitored scheme-wise/project-wise by the Additional Secretary & FA of the Department of Space to ensure that the allocated funds are fully utilised. Accordingly, while formulating the Revised Estimates 2013-2014, a critical appraisal of the progress - both physical and financial is carried out consistent with the programmatic requirements. Quarterly targets are fixed for each major project/scheme during the beginning of the year and the Additional Secretary & FA of the Department takes a rigorous review of the expenditure/commitment status on a monthly basis to ensure that the financial and programmatic targets are realized. The project management councils/project management boards of all the major projects constituted at the DOS/ISRO Centre level also review the progress of expenditure/commitment status and initiate necessary follow-up actions keeping in view the programmatic criticalities. Thus, periodical review of the physical and financial performance of all the projects/schemes is an integral part of the planning and implementation strategy of DOS/ISRO.

3. The Financial performance of the Department in terms of Budget Estimates, Revised Estimates and Actual expenditure for the last three years viz., 2010-2011, 2011-2012 and 2012-2013 are given below:

### Financial performance 2010-2011

(₹ in crores)

	Non-Plan	Plan	Total
Budget Estimates 2010-2011	778.00	5000.04	5778.04
Revised Estimates 2010-2011	880.00	4000.04	4880.04
Actual Expenditure 2010-2011	878.83	3603.40	4482.23

4. The Revised Estimates 2010-2011 was reduced to ₹4880.04 crores in compliance with the reduced ceilings fixed by the Ministry of Finance. The actual expenditure during the year was ₹4482.23 crores which is about 91.85% budget utilization with respect to RE.

**Financial performance 2011-2012**

(₹ in crores)

	<b>Non-Plan</b>	<b>Plan</b>	<b>Total</b>
Budget Estimates 2011-2012	926.00	5700.04	6626.04
Revised Estimates 2011-2012	1000.00	3432.04	4432.04
Actual Expenditure 2011-2012	999.18	2785.08	3784.27

5. The Revised Estimates 2011-2012 was reduced to ₹ 4432.04 crores in compliance with the reduced ceilings fixed by the Ministry of Finance. The actual expenditure during the year was ₹ 3784.27 crores which is about 85.38% budget utilization with respect to RE.

**Financial performance 2012-2013**

(₹ in crores)

	<b>Non-Plan</b>	<b>Plan</b>	<b>Total</b>
Budget Estimates 2012-2013	1100.00	5615.04	6715.04
Revised Estimates 2012-2013	1080.00	3800.03	4880.03
Actual Expenditure 2012-2013	1073.05	3783.23	4856.28

6. The Revised Estimates 2012-2013 was reduced to ₹ 4880.03 crores in compliance with the reduced ceilings fixed by the Ministry of Finance. The actual expenditure during the year was ₹ 4856.28 crores which is about 99.51% budget utilization with respect to RE.

7. The scheme-wise/project-wise details of BE, RE and Actuals for 2012-2013, BE & RE for 2013-2014 and BE for 2014-2015 are given in Table 5.1 enclosed.

8. 1 334 Utilization Certificates are outstanding as on 31.03.2014. Continuous follow-up action is being taken with the grantee institutions for submission of Fund Utilization Certificates duly supported by statement of audited accounts in respect of the above 334 cases.

8.2 In addition to the above, the Department has also evolved effective mechanisms to monitor the physical progress of the sponsored research projects. The duration of such research projects is generally 3 to 5 years. Periodical reviews, both physical and financial, are carried out every year by an expert committee to assess the research progress and recommend the grants to be released to such projects for the following year. The mechanism ensures that the funds released to the projects are utilized for the intended purposes.

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# Department of Space

TABLE-5.1

## Scheme-wise/Project-wise details for the period from 2012-2015

(₹ in Crores)

Sl. No.	Programmes/Projects/Centres/Units	Budget 2012-2013	Revised 2012-2013	Actuals 2012-2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
<b>A</b>	<b>SPACE TECHNOLOGY</b>						
<b>I</b>	<b>Launch Vehicle Technology</b>						
1	Cryogenic Upper Stage Project	0.10	0.10	0.00	0.10	0.10	0.10
2	PSLV-Continuation Project	380.00	170.00	170.00	350.00	162.68	390.00
3	GSLV Mk-III Development	72.09	72.10	72.10	139.53	80.13	180.10
4	Space Capsule Recovery Experiment - I & II	2.20	1.00	1.00	0.50	0.05	0.25
5	GSLV – Operational Project (including Mk-III Operational)	258.96	250.00	255.00	215.91	180.00	203.67
6	Vikram Sarabhai Space Centre	784.36	652.62	660.92	732.87	711.00	988.67
7	ISRO Inertial Systems Unit	62.67	56.26	57.48	69.01	68.00	76.88
8	Liquid Propulsion Systems Centre	436.35	344.39	340.13	439.09	346.00	278.05
	ISRO Propulsion Complex	0.00	0.00	0.00	0.00	0.00	193.50
9	Manned Mission Initiatives/Human Space Flight Programme	60.46	14.00	10.00	27.00	10.00	17.50
10	Indian Institute of Space Science & Technology	100.00	50.00	64.83	150.50	75.00	122.50
11	Semi Cryogenic Engine Development	150.00	84.96	84.95	180.00	65.00	150.00
12	Trisonic Wind Tunnel Project	0.00	0.00	0.00	0.00	0.00	10.00
	<b>Sub-Total</b>	<b>2307.19</b>	<b>1695.43</b>	<b>1716.41</b>	<b>2304.51</b>	<b>1697.96</b>	<b>2611.22</b>
<b>II</b>	<b>Satellite Technology</b>						
13	Resourcesat-2 & 3	10.50	0.80	0.78	0.00	0.00	0.00
14	Oceansat- 2 & 3	50.00	0.00	0.00	0.00	0.00	0.00
15	RISAT-1	0.25	0.90	0.43	0.00	0.00	0.00
16	Advanced Communication Satellite (GSAT 11 including Launch Services)	250.00	119.50	89.97	203.00	140.00	164.50
17	Navigation Satellite System (including IRNSS)	170.00	134.15	146.97	135.00	115.00	120.00
18	ISRO Satellite Centre	471.06	321.43	318.64	356.80	296.00	369.16
19	Laboratory for Electro-Optics System	54.78	35.12	32.86	38.60	35.00	60.13
20	Semi-conductor Laboratory	75.47	75.47	61.20	105.64	68.00	114.27



Sl. No.	Programmes/Projects/Centres/Units	Budget 2012-2013	Revised 2012-2013	Actuals 2012-2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
21	Earth Observation-New Missions (Cartosat-3, Hyperspectral, GISAT, DMSAR-1, ENVISAT, SCATSAT, RISAT-3 & Future EO Missions)	50.00	2.20	4.46	0.01	0.00	0.00
22	SARAL	15.00	19.00	19.46	10.00	11.00	0.00
23	Geo-Imaging Satellite (GISAT)	50.00	23.50	24.00	80.00	46.00	63.00
24	Resourcesat-2A	0.00	0.00	0.00	28.00	15.00	50.00
25	Cartosat-3	0.00	0.00	0.00	10.00	0.00	10.00
26	Scattsat	0.00	0.00	0.00	5.00	0.00	10.00
27	RISAT-1A	0.00	0.00	0.00	1.00	0.00	1.00
28	Oceansat-3	0.00	0.00	0.00	5.00	0.00	25.00
29	Cartosat-2E	0.00	0.00	0.00	0.00	0.00	25.00
30	Risat-3	0.00	0.00	0.00	0.00	0.00	1.00
	<b>Sub- Total</b>	<b>1197.06</b>	<b>732.07</b>	<b>698.77</b>	<b>978.05</b>	<b>726.00</b>	<b>1013.06</b>
31	Satish Dhawan Space Centre - SHAR	437.84	353.86	362.60	457.83	411.00	508.30
32	ISRO Telemetry, Tracking and Command Network	126.02	104.02	118.71	129.26	130.00	157.04
33	Second Vehicle Assembly Building (SVAB)	0.00	0.00	0.00	0.00	0.00	50.00
	<b>Sub- Total</b>	<b>563.86</b>	<b>457.88</b>	<b>481.31</b>	<b>587.09</b>	<b>541.00</b>	<b>715.34</b>
	<b>TOTAL : A - SPACE TECHNOLOGY</b>	<b>4068.11</b>	<b>2885.38</b>	<b>2896.49</b>	<b>3869.65</b>	<b>2964.96</b>	<b>4339.62</b>
<b>B</b>	<b>SPACE APPLICATIONS</b>						
1	Space Applications Centre	306.55	304.57	296.99	336.08	306.00	426.03
2	Development & Educational Communication Unit	51.12	15.06	14.15	46.75	19.28	40.80
3	Earth Observation Applications Mission	2.80	1.49	1.44	4.37	2.06	4.03
4	National Natural Resources Management System	53.74	22.50	21.69	31.50	18.00	30.30
5	North Eastern Space Applications Centre	8.00	8.00	2.10	8.00	15.23	21.80
6	Disaster Management Support	30.38	12.00	9.94	30.42	14.00	21.37
7	National Remote Sensing Centre	273.52	214.87	206.61	199.00	192.51	244.09
8	Indian Institute of Remote Sensing (IIRS)	32.48	24.03	22.43	30.35	25.94	40.55
	<b>TOTAL : B - SPACE APPLICATIONS</b>	<b>758.59</b>	<b>602.52</b>	<b>575.35</b>	<b>686.47</b>	<b>593.02</b>	<b>828.97</b>
<b>C</b>	<b>SPACE SCIENCES</b>						
1	Physical Research Laboratory	111.90	65.48	55.89	141.46	90.00	156.80
2	ISRO Geosphere-Biosphere Programme	27.69	22.50	16.47	26.73	14.00	20.00



Sl. No.	Programmes/Projects/Centres/Units	Budget 2012-2013	Revised 2012-2013	Actuals 2012-2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
3	Sensor Payload Development/Planetary Science Programme	20.00	1.50	1.41	3.53	0.38	2.60
4	Megha-tropiques Project	0.40	0.23	0.21	0.00	0.00	0.00
5	ADITYA	20.00	3.40	3.37	20.00	5.00	27.00
6	Indian Lunar Mission-Chandrayaan-1&2	82.50	56.01	64.94	78.00	24.00	60.00
7	Astrosat-1 & 2	6.00	2.55	2.49	5.00	2.25	4.50
8	National Atmospheric Research Laboratory (NARL)	17.20	14.03	14.03	20.57	15.00	22.96
9	National Institute of Climate Change and Environment Studies (NICES)	1.00	0.00	0.00	0.00	0.00	0.00
10	Sponsored Research (RESPOND)	21.80	21.20	14.88	22.80	12.00	21.72
11	Atmospheric Science Programme	18.70	7.92	7.79	21.80	13.81	23.37
12	Small Satellites for Atmospheric Studies & Astronomy	2.46	2.00	1.60	5.00	1.00	2.60
13	Other Schemes	17.10	8.31	7.28	8.90	2.06	5.75
14	Mars Orbiter Mission	125.00	125.00	122.64	167.50	225.00	71.00
	<b>TOTAL : C - SPACE SCIENCES</b>	<b>471.75</b>	<b>330.13</b>	<b>313.00</b>	<b>521.29</b>	<b>404.50</b>	<b>418.30</b>
D	<b>DIRECTION &amp; ADMINISTRATION/OTHER PROGRAMMES</b>						
1	Department of Space Secretariat	9.12	10.10	10.11	10.48	21.60	27.20
2	Indian Space Research Organisation (ISRO) Headquarters	66.38	65.44	64.85	68.75	66.20	71.80
3	International Co-operation	2.80	2.70	2.72	3.80	2.06	3.87
4	Other Programmes (Spl Indigenisation/advance ordering, etc.)	117.42	23.06	19.67	51.39	83.85	100.07
	<b>TOTAL D: DIRECTION, ADMINISTRATION &amp; OTHER PROGRAMMES</b>	<b>195.72</b>	<b>101.30</b>	<b>97.35</b>	<b>134.42</b>	<b>173.71</b>	<b>202.94</b>
E	<b>INSAT OPERATIONAL</b>						
1	INSAT-3 Satellites	36.50	21.86	23.57	25.30	16.00	10.00
2	INSAT-3 Launch Services	0.00	0.00	0.00	0.00	0.00	0.00
3	INSAT-4 Satellites (including leasing of Transponders)	390.90	133.42	192.37	97.00	69.35	37.90
4	Service Charges for Leasing of Transponders	170.00	40.00	39.96	200.00	48.85	75.24
5	INSAT-4 Launch Services	81.00	47.00	0.00	0.00	0.00	0.00
6	GSAT-7 Satellites (Launch Services)	207.70	448.51	448.51	14.00	37.00	1.05
7	Master Control Facility	70.52	48.91	48.77	73.91	56.25	84.07
8	INSAT-3D Launch Services	264.25	221.00	220.91	270.00	265.00	1.15

Sl. No.	Programmes/Projects/Centres/Units	Budget 2012-2013	Revised 2012-2013	Actuals 2012-2013	Budget 2013-2014	Revised 2013-2014	Budget 2014-2015
9	GSAT-15 Satellite	0.00	0.00	0.00	100.00	26.00	110.00
10	GSAT-15 Satellites-Launch Services	0.00	0.00	0.00	300.00	221.20	378.00
11	GSAT-16 Satellites	0.00	0.00	0.00	95.00	75.00	110.00
12	GSAT-16 Satellites-Launch Services	0.00	0.00	0.00	305.00	221.20	433.00
13	GSAT-17 Satellite	0.00	0.00	0.00	90.00	0.00	50.00
14	GSAT-17 Satellite- Launch Services	0.00	0.00	0.00	10.00	0.00	10.00
15	GSAT-18 Satellite	0.00	0.00	0.00	0.00	0.00	50.00
16	GSAT-18 Satellite- Launch Services	0.00	0.00	0.00	0.00	0.00	10.00
17	GSAT-19 Satellite	0.00	0.00	0.00	0.00	0.00	10.00
18	GSAT follow-on Satellites including Launch Services	0.00	0.00	0.00	0.00	0.00	20.00
19	Augmentation of Capacity through leasing of transponders from foreign Satellite	0.00	0.00	0.00	0.00	0.00	47.80
20	Procurement of Heavier class of Satellites	0.00	0.00	0.00	0.00	0.00	10.00
	TOTAL : E - INSAT OPERATIONAL	1220.87	960.70	974.09	1580.21	1035.85	1448.21
	GRAND TOTAL : GROSS	6715.04	4880.03	4856.28	6792.04	5172.04	7238.04
	Deduct Recoveries	0.04	0.03	0.00	0.04	0.04	0.04
	TOTAL : (NET)	6715.00	4880.00	4856.28	6792.00	5172.00	7238.00

## AUTONOMOUS BODIES OF DOS/ISRO

### 1. Physical Research Laboratory (PRL)

(₹in crores)

<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
141.46	90.00	156.80

1.1 The Physical Research Laboratory (PRL) at Ahmedabad is an autonomous Institution supported mainly by the Department of Space. It is a premier Institute engaged in basic research in the fields of Astronomy, Planetary, Space, Atmospheric & Earth Sciences and Theoretical Physics. Academic programmes of PRL also include Doctoral & post-Doctoral research, summer programmes for science & engineering graduate students, Associateship programme for University teachers and outreach activities for high school students and general public.

### 1.2 Major Achievements during 2013-2014

- Detection of previously reported exo-planet around Sun-like stars using indigenously developed Optical Echelle Spectrograph;
- Multi-application Solar Telescope has been installed at the Udaipur Lake site. Preliminary check tests are done and observational runs are being conducted to check specifications;
- The last solar minima, the deepest in the past hundred years, resulted from active changes in solar dynamo starting in 1996 leading to decline in solar Polar fields;
- Detection of water in rare 'melt-inclusion' in lunar rock that provides insight on water content of the lunar mantle;
- Analysis of remote sensing lunar surface data suggest presence of young viscous flow of impact or volcanic origin;
- Detection of geomorphic signatures of past glacial activity on Mars;
- Studies on the role of solar forcing in vertical coupling in the atmosphere;
- Size-segregated aerosol chemical composition in micron to sub-micron range, that plays an important role on radiative effects over the tropics, has been investigated;
- Reconstructed a four thousand year long record of past monsoon from studies of Cave-ice deposit in Andaman Island;
- Fabrication of flight model of two payloads for the Chandrayaan-2 mission is in progress;
- Design and development of two proposed payloads for a Lunar Lander mission will be initiated;

### 1.3 Major Programmes for 2014-2015

- Search and detection of specific earth-like exo-planets based on detailed observation of probable candidates from 'Kepler' mission observations;
- Studies of global climate change at short (decadal) to longer (hundred to thousand years) time scale; Anthropogenic versus natural effects;
- Early evolution of the solar system : processes and time scales, analysis of lunar, meteorite and interstellar dust using SEM, Nano-SIMS, NG-MS and MC-ICPMS;
- Study on water and other volatiles in moon; its occurrence and distribution;
- Analysis of remote sensing data to understand the evolution histories of the lunar and martian surface features;
- Studies of atmosphere :coupling between various atmospheric layers/boundaries;
- Continuing studies of river-ocean interactions in the Indian region and its influence in global ocean cycle;
- Understanding Early Universe, Higgs and physics beyond the Standard Model;
- Experimental studies on Molecular Physics, Optical Vortices and parametric oscillators;
- Establishing new facilities proposed under the 12<sup>th</sup> Five Year Plan : Proton mass spectrometer, Laboratory studies of photon entanglement in quantum domain.

## 2. National Atmospheric Research Laboratory (NARL)

(₹ in crores)

<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
20.57	15.00	22.96

2.1 The National Atmospheric Research Laboratory (NARL) at Gadanki near Tirupati in Andhra Pradesh, is an autonomous Institution fully funded by the Department of Space, Government of India. The main activities of NARL are (i) carrying out fundamental research related to Earth's atmosphere using a variety of state-of-the-art equipments such as the Mesosphere-Stratosphere-Troposphere (MST) Radar, lidars, wind profilers, GPS balloon sonde, automatic weather station etc., (ii) research and development of advanced technology for atmospheric studies and transfer of the same to Indian industries and (iii) Modeling and prediction of weather and climate. NARL encourages national and international Institutes and Universities to make use of its facilities for front ranking research in atmospheric science.

## **2.2 Major Achievements during 2013-2014**

- A HF radar operating in 30 MHz has been developed exclusively for ionospheric studies which is now being evaluated for its data quality and consistency;
- Conducted campaigns involving airglow imager and MST radar to identify spatial structure in the ionosphere prior to the onset of equatorial bubbles (EPB). Large scale spatial wave structures were detected and attempts are made to understand the link between these structures with the EPB structures;
- By using the O<sub>2</sub> airglow temperature data, the Rayleigh lidar capabilities have been stretched to study the temperature fluctuations created by short period gravity waves;
- The denser network of dual frequency GPS receivers at Gadanki, Tirupathi, Arrakonam, Sriharikota and Chennai have been made operational;
- Humidity profiles obtained from SAPHIR onboard Mega Tropique were evaluated using data sets derived from GPS radiosondes, ground-based radiometer, reanalysis data sets and other satellite retrievals;
- Operation of a Climate Observatory at Gadanki where regular observations of essential climate change variables such as concentration of aerosols, carbon dioxide, black carbon, ozone, oxides of nitrogen and radiation parameters such as direct solar radiation, global radiation etc are made;
- NARL issues real time forecast to SDSC-SHAR during launch operations;
- The Raman lidar technology for atmospheric water vapour measurements has been filed for intellectual property rights (IPR) under ISRO;
- A cost effective lidar system has been developed for convective boundary layer (CBL) measurements which also provides high resolution cloud base measurements during convective periods.

## **2.3 Major Programmes for 2014-2015**

- Planned to refurbish the existing MST radar with state-of-the-art transmitter/receiver modules. Towards this a feasibility study has already been completed successfully;
- Planned to complete conversion of the MST radar into a fully active array system;
- Proposed to install and operationalize a state of art digital ionosonde which will monitor various ionospheric processes round the clock;

- Envisaged to develop a high performance Mesosphere Lower Thermosphere Photometer to measure the airglow intensities emanating from various ionospheric layers which will complement the ionosonde data in predicting the generation of equatorial plasma bubbles;
- Proposed to install and commission a Brewer MKIII spectrophotometer for continuous monitoring of the stratospheric ozone layer;
- Planned to take up indigenous development of a Differential Absorption Lidar (DIAL) for ozone profile measurement and the new system will be realized in about four years time;
- An X-Band Polarimetric radar is being developed in collaboration with ISTRAC and the system is expected to be tested and made fully operational during 2014-15;
- Planned to augment the Climate Observatory operational at Gadanki will by including methane monitor and organic/black carbon analyzer;
- Development and demonstration of a tethered balloon observation platform is envisaged during the 2014-15 year period.

### 3. North-Eastern Space Application Centre (NE-SAC)

(₹ in crores)

<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
8.00	15.23	21.80

3.1 The North-Eastern Space Applications Centre (NE-SAC) located at Shillong is an autonomous society set up jointly with the North-Eastern Council to support the North-Eastern Region by providing information on natural resources utilisation & monitoring, infrastructure developmental planning & interactive training using space technology inputs of remote sensing & satellite communication. The Centre networks with the State Governments in the North- Eastern Region and the North-Eastern Council for generating solutions for the developmental activities of the Region.

### 3.2 Major Achievements during 2013-2014

- The final Forest Working Plan for the Lunglei and North Vanlaiphai Division have been approved by the MoEF, under the project on Remote Sensing and GIS inputs for forest working plan preparation in Mizoram, Meghalaya, Arunachal Pradesh and Assam;
- Under the project to generate geospatial technology inputs for various agricultural planning, the assessment of agriculture areas during winter and summer season at district level in Assam has been completed;

- Mapping of potential areas for sericulture development has been completed for all the selected 108 districts and maps and statistics have been shared with State user departments. The web portal named Sericulture Information Linkages and Knowledge System (SILKS) developed under the project has been hosted in public domain;
- Preparation of resources theme layers such as settlements, infrastructure and land cover at 1:10,000 scale is in progress in all the states of the NE-region. Under the NRC-Rajiv Gandhi National Drinking Water Mission (RGNDWM-Phase IV), project ground water prospect mapping, considering the lithological, structural, geomorphological and hydrological parameters have been completed for the state of Meghalaya;
- Under SATCOM programme, rectification of 19 SITs of EDUSAT network in Assam & Meghalaya was done using spares made available at NE-SAC. A user meet was conducted for North-East EDUSAT networks at NE-SAC jointly with DECU. The entire responsibility of tele-education in NE-region is now being transferred to NE-SAC;
- Under Telemedicine Program in NER states, renewal of deployment of Technicians has been done in the working telemedicine centres in NER under ISRO-NEC. Under the Village Resource Project (VRC) project in North-Eastern States, recorded an audio-visual content on 'Sali Rice Farming in Assam' utilizing all available audio-visual resources in collaboration with ABITA-GKUP in SATCOM studio for the farmers of villages of Assam coming under VRC network;
- A land aerosol campaign was conducted along the North-South corridor of NER. Online Gas analysers for Carbon-monoxide (CO), Oxides of Sulphur (SO<sub>x</sub>), Oxides of Nitrogen (NO<sub>x</sub>), Ozone (O<sub>3</sub>) and Methane non-methane Hydrocarbon has been procured along with calibration system, centralized data logging system and moisture removal system from the inlet. The AMSU radiance data has been assimilated in the WRF model and this has improved the accuracy of rainfall forecast further. The Automatic weather station in NE-SAC has been fitted with a fuel cell power system developed by the Lithium Ion and Fuel Cell Division, VSSC, Thiruvananthapuram and operationalized jointly by NE-SAC and VSSC;
- EOAM funded projects on mapping of forest flora and identification of potential areas for medicinal & aromatic plants in East Khasi Hills district of Meghalaya, GIS mapping of mosquito vector borne diseases in north east India and Development of effective classification schemes for hyper spectral satellite data with potential applications in NER are in progress;
- The projects on study on bio-ecology of Tea Mosquito bug (*Helopeltis theivora*) funded by Dept. of Biotechnology, Govt. of India and Impacts of land-use/land-cover change with particular reference to forest cover and habitation pattern on the climate of Barak basin in North-Eastern India funded under IGBP are in progress during 2013-14;
- Flood Early Warning System (FLEWS) in its four years of existence has been able to cover 15 major flood prone districts of Assam. At the same time the percentage of success of early warnings has also been increased. NE-SAC also monitors and prepares status report on agricultural drought for the whole of NER using satellite and surface based observation.



### 3.3 Major Programmes for 2014-2015

- The following remote sensing and GIS application projects will continue/initiated during 2014-15:
  - Remote sensing and GIS inputs in preparation of forest working plans and schemes for entire North-Eastern Region;
  - Soil and land capability mapping of all agricultural districts of North-Eastern Region;
  - Space Based Information Support for Decentralized Planning (SIS-DP) for NER;
  - North-Eastern District Natural Resources Plan;
  - Space Based Information System on North Eastern Region (SBIK-NER);
  - Impacts of land use/land cover change with particular reference to forest cover and habitation pattern on the climate of Barak basin in North-Eastern India;
  - Studies on bio-ecology of Helopeltistheivora and development of a forecasting model;
  - Soil Health Card for a selected micro watershed of Ri-Bhoi District of Meghalaya;
  - Above ground biomass estimation using SAR data in tropical and subtropical forests of North East India;
  - Water balance analysis of Umiam reservoir in Meghalaya;
  - Understanding the airborne hyperspectral remote sensing for potential applications in NER;
  - Utilisation of SAR/RISAT data;
  - LIDAR/ALTM applications
- Expansion activity of EDUSAT network in NER states by installing new SIT;
- Commissioning of remaining telemedicine centres under ISRO-NEC telemedicine project;
- Expansion of VRC network in NER states as per plan;
- Better utilization of the studio for content generation programs for societal development, disaster management awareness, distance education etc.;
- GSAT- 4 Application Project (GAP-4): Installation and commissioning of the system as per the project plan of SAC/ISRO and start the activities related to the experiment;
- Conduct land aerosol campaign covering E-W and N-S of NER during different seasons and estimate radiative forcing;

- Establishment of laboratory for Space weather and Ionospheric studies. Participation in CAWSES-India programme by setting up node under National Space Weather observational Network in India;
- High resolution weather forecasting for NER using both WRF and MM5 model. Experiment to be continued with different physical schemes to identify the one most suitable for NER;
- The agro meteorological advisory services shall be extended to other regions of NER having VRC network;
- Spectro-Radiometer to be used for establishing signature library for hyper-spectral studies;
- Establishment of High Power Computing System for numerical weather prediction;
- Thunderstorm forecasting for Mizoram state and extension of the Flood Early Warning System (FLEWS) by integrating inputs from various stakeholders involved in flood management. Emphasis will be given to forecast the extent and level of inundation with larger lead time;
- Operationalization of NER-DRR;
- Expansion of agricultural drought assessment;
- Capacity building in DMS through EDUSAT network utilization.

#### 4. Semi-conductor Laboratory (SCL)

(₹ in crores)

<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
105.64	68.00	120.00

4.1 SCL is entrusted with the task of Research & Development in the field of Microelectronics to meet the strategic need of the country in this vital area. SCL is engaged in the design, development, manufacturing, testing & assembly, packaging of CMOS, Imaging and MEMS devices, including development of Process Technology for various strategic applications. It is also involved in Hi-Rel Board fabrication & component screening for ISRO, indigenization of Electronic Boards for Air Force and production of Dr. Pisharoty Radio Sonde Systems for Atmospheric Studies. While the Design, Assembly, Testing, Quality/Reliability Assurance Facilities are already in place, the Manufacturing facility is being upgraded from 0.8µm CMOS 6" Wafer Fabrication to 0.18µm CMOS 8" Wafer Fabrication. The development and manufacture of ASICs for strategic sector is the major thrust area.

## **4.2 Major Achievements during 2013-2014**

- All Process & Metrology Tools/Equipment for the 8" CMOS Wafer Fab line are installed. 66 out of the 68 equipment are accepted / qualified and are in operation. The remaining 2 equipment are scheduled to be qualified during October 2013;
- As regards Process implementation, the Unit Step Development activity is nearing completion. Out of a total of 102 Unit Steps in the 0.18µm CMOS Process, 96 Unit Steps are released for Process Integration while the remaining 6 Unit Steps are being progressed and scheduled to be completed towards end October 2013;
- Full flow integration lots (4 Nos.) are being processed in a pipeline mode for process freeze and SRAM (Technology Transfer Vehicle) functionality. Concurrently, Module verification lots are being run for process feedback for incorporation in the integration lots. The first integration lot is scheduled to fab out by end December 2013 whereupon SRAM functionality shall be tested and process freeze accomplished. The 8" CMOS Fab with 0.18µm technology node is targeted to be ready for production from February 2014;
- Design of 9 no. ASICs/IP Blocks viz. On-Board Controller 1.1 ASIC, Video Processor Logic, Timing Sequencer, Sigma-Delta ADC, OPAMP, Quad LVDS, Communication Protocol, Asynchronous SRAM and ASDR ASIC, in keeping view the requirements of ISRO centers is complete for prototyping. Proven Designs will be fabricated in the SCL Fab upon operationalization in February 2014;
- In MEMS area, while Temperature Sensor has been qualified, Pressure and RH Sensors are undergoing qualification. These MEMS devices will be used for various applications including atmospheric studies. 8 more MEMS Devices are under various stages of development in the MEMS line;
- A total of 961 Radio Sonde boards have been delivered till September, 2013 as per the requirement received from the user. Out of the order of 60 RSU PCBs 20 shall be supplied to 3 BRD Air Force Station, Chandigarh by March 2014; Out of 14K devices comprising of 9 types of ASICs to be supplied to Indian Railways for use in 3 Phase Electric Locomotive during the year, 3K ASICs have been supplied till September 2013;
- Screening of total 48K active and passive devices is targeted for various ISRO center during the year. About 15K devices have been screened till September 2013.

## **4.3 Major Programmes for 2014-2015**

- Commencement of production from the 8" CMOS Fab. ASICs for various strategic organizations are planned for production;
- Yield optimization and production ramp-up in the 8" CMOS Fab;

- Design of various ASICs viz. as LVDS(1 Gbps), CMOS Camera Configurator, Programmable Bias Voltage Gen., On-board Controller 2.1S, CCD Signal Processor, Protocol Controller (1553), i2C Communication Protocol, Cold Sparing I/O Pads, PLL (1.2 Ghz) and fabrication in the 8" fab will be taken up during the year;
- Development of MEMS devices viz. Acoustic sensor (100 to 180 dB), Pyro-Thruster, Micro-Valve, Accelerometer (3g and 30g), Gyroscope, Phase Shifter (X & K-band) Si detector shall be carried out in the 6" MEMS Fab line;
- Enhancement in the base line 180 nanometer technology to support design of Analog/Mixed Signal ASICs and Radiation Tolerant Devices, CCD Process porting on the 8" line will be progressed during the year in keeping with needs of the strategic organizations;
- Development of 6" Silicon Detector for use in Advanced Experimentation at CERN will be undertaken in 6" fabline;
- Production level of both Dr. Pisharoty Sonde and Wind Sonde will be maintained at 400 boards per month. Systems Assembly of Firemod Kit and other Professional Board as per the requirement of Air Force is also planned;
- Total of 40 RSU PCBs shall be supplied to 3 BRD Air Force Station, Chandigarh;
- About 16K Nos of nine variants of ASICs are targeted to be supplied to Railways for use in their 3 Phase Electric Locomotive;
- Screening capability & capacity to be further increased with emphasis on Active Components. Tentative target is 18K Active and 30K of Passive Devices;
- Hi-Rel fabrication/assembly of on-board cards for SAC and LPSC shall also be continued during the year.

## 5. Indian Institute of Space Science & Technology (IIST)

(₹ in crores)

<b>Budget 2013-2014</b>	<b>Revised 2013-2014</b>	<b>Budget 2014-2015</b>
150.50	75.00	122.50

5.1 The Indian Institute of Space Science and Technology (IIST), an autonomous body under DOS was established with the primary objective of creating world class Institution in the area of advanced Space Science and Technology education and generating high quality human resources to meet the quality manpower requirements of DOS/ISRO. The Institute has undergraduate, postgraduate and doctoral programmes in the area of space science technology and applications. The Institute has started functioning from the academic year 2007-2008, in the infrastructure provided by the Vikram Sarabhai Space Centre in Thiruvananthapuram. IIST has started functioning from its own campus at Valiamala, w.e.f. August 15, 2010. The annual intake of students to the Institute is about 150-200.

5.2 The Institute shifted to its new campus in Valiamala in August 2010. The campus construction activities, which commenced in December 2008 gained more momentum after the Institute was shifted to the new campus. Two academic blocks, 11 hostels and canteen along with services have been completed. Balance academic blocks is nearing completion and work on students activity centre is in progress. Govt. of Kerala has handed over nearly the entire stretch of land acquired for IIST, barring a few patches. The setting up of laboratories is in progress. A well-equipped library with subscriptions to several print & e-journals were also set up. Moreover, internet, medical, sports and canteen facilities have also been established in the new campus for the benefit of students, faculty and staff.

5.3 The Institute is in the process of creating adequate scientific and technical infrastructure for supporting academics and high quality research. A number of well qualified and experienced faculty members have joined the Institute from many reputed Institutions in the country and abroad. The recruitment process for faculty, technical staff and administrative staff is continuing. A number of administrative responsibilities have been outsourced for better efficiency.

#### **5.4 Major Achievements during 2013-2014**

- Second convocation of IIST was held on June 3, 2013;
- Peer team from National Assessment and Accreditation Council (NAAC) visited IIST between 15-17 April, 2013. NAAC has accredited IIST on July 8, 2013;
- New building for administration departments and library completed and occupied;
- Construction of 3<sup>rd</sup> and 4<sup>th</sup> Academic Blocks expected to be completed by March, 2014;

#### **5.5 Major programmes for 2014-2015**

- The Institute has plans to offer post-graduate degree programmes in several niche areas;
- Planned to initiate Post-Doctoral Programme in order to take research activities to the next level;

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